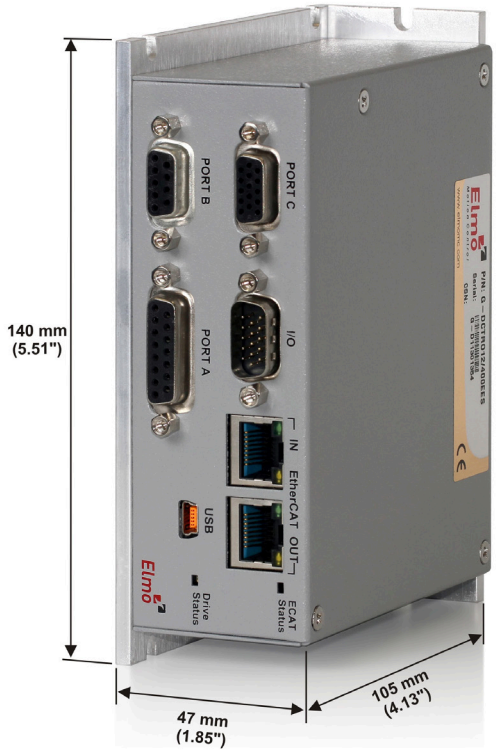
Gold Line

Gold DC Trombone Digital Servo Drive Installation Guide

EtherCAT and CAN



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Elmo
Motion Control

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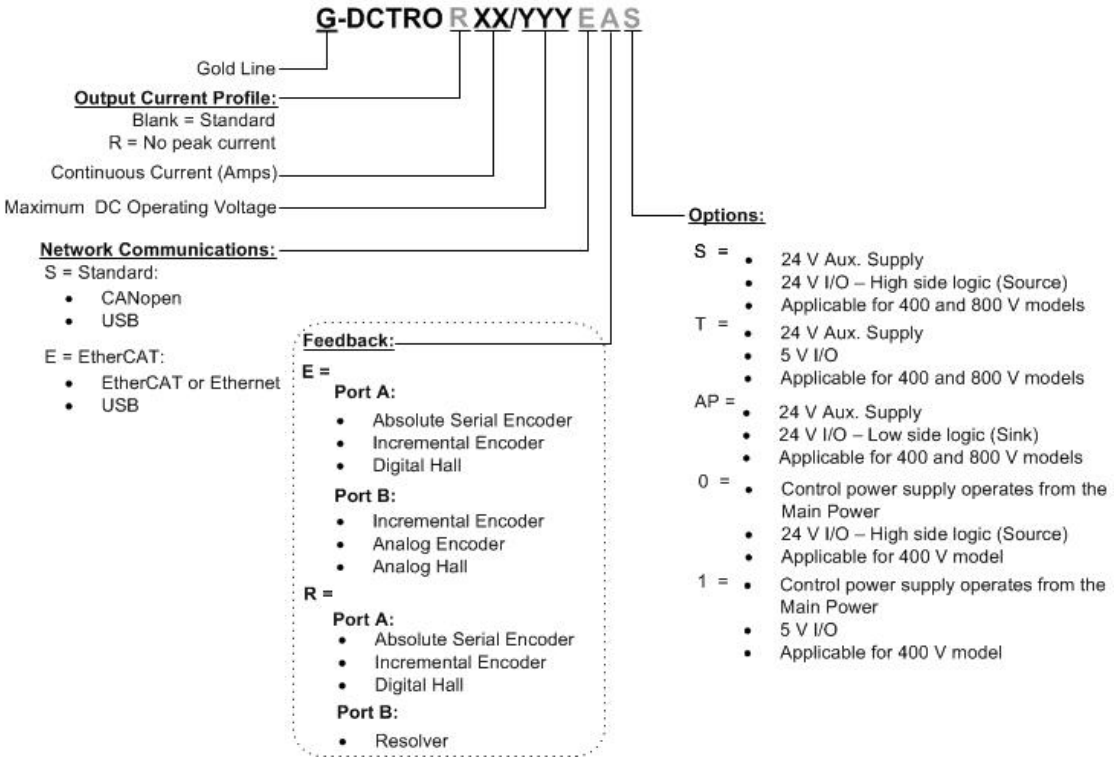

Revision History

Version	Details
1.0	Initial release
1.1	Several updates throughout the manual
1.2	Updated catalog number and various updates throughout the manual. Sections 4.3 and 4.3.1: Auxiliary Supply Voltage range: 18 V to 30 V
1.3	Changes throughout document to allow mini USB and general changes.
1.4	Updated to change P/N details on Feedbacks Absolute - included as standard.
1.5	Change the overvoltage in 800 V mode, Pin layout, UL recognition, and further optional versions added
1.6	EtherCAT and CAN merged into one document.

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Chapter 1: Safety Information

In order to achieve the optimum, safe operation of the Gold DC Trombone servo drive, it is imperative that you implement the safety procedures included in this installation guide. This information is provided to protect you and to keep your work area safe when operating the Gold DC Trombone and accompanying equipment.

Please read this chapter carefully before you begin the installation process.

Before you start, ensure that all system components are connected to earth ground. Electrical safety is provided through a low-resistance earth connection.

Only qualified personnel may install, adjust, maintain and repair the servo drive. A qualified person has the knowledge and authorization to perform tasks such as transporting, assembling, installing, commissioning and operating motors.

The Gold DC Trombone servo drive contains electrostatic-sensitive components that can be damaged if handled incorrectly. To prevent any electrostatic damage, avoid contact with highly insulating materials, such as plastic film and synthetic fabrics. Place the product on a conductive surface and ground yourself in order to discharge any possible static electricity build-up.

To avoid any potential hazards that may cause severe personal injury or damage to the product during operation, keep all covers and cabinet doors shut.

The following safety symbols are used in this manual:

Warning:
This information is needed to avoid a safety hazard, which might cause bodily injury.

Caution:
This information is necessary for preventing damage to the product or to other equipment.

1.1. Warnings

- To avoid electric arcing and hazards to personnel and electrical contacts, never connect/disconnect the servo drive while the power source is on.
- Power cables can carry a high voltage, even when the motor is not in motion. Disconnect the Gold DC Trombone from all voltage sources before it is opened for servicing.
- The Gold DC Trombone servo drive contains grounding conduits for electric current protection. Any disruption to these conduits may cause the instrument to become hot (live) and dangerous.
- After shutting off the power and removing the power source from your equipment, wait at least 1 minute before touching or disconnecting parts of the equipment that are normally loaded with electrical charges (such as capacitors or contacts). Measuring the electrical contact points with a meter, before touching the equipment, is recommended.

1.2. Cautions

- The Gold DC Trombone servo drive contains hot surfaces and electrically-charged components during operation.
- The maximum DC power supply connected to the instrument must comply with the parameters outlined in this guide.
- When connecting the Gold DC Trombone to an approved isolated 18–30 VDC auxiliary power supply, connect it through a line that is separated from hazardous live voltages using reinforced or double insulation in accordance with approved safety standards.
- Before switching on the Gold DC Trombone, verify that all safety precautions have been observed and that the installation procedures in this manual have been followed.

1.3. Directives and Standards

The Gold DC Trombone conforms to the following industry safety standards:

Safety Standard	Item
Approved **IEC/EN 61800-5-1, Safety**	Adjustable speed electrical power drive systems
Recognized **UL 508C**	Power Conversion Equipment
In compliance with **UL 840**	Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
In compliance with **UL 60950-1** (formerly **UL 1950**)	Safety of Information Technology Equipment Including Electrical Business Equipment
In compliance with **EN 60204-1**	Low Voltage Directive 73/23/EEC

The Gold DC Trombone servo drive has been developed, produced, tested and documented in accordance with the relevant standards. Elmo Motion Control is not responsible for any deviation from the configuration and installation described in this documentation. Furthermore, Elmo is not responsible for the performance of new measurements or ensuring that regulatory requirements are met.

1.4. CE Marking Conformance

The Gold DC Trombone servo drive is intended for incorporation in a machine or end product. The actual end product must comply with all safety aspects of the relevant requirements of the European Safety of Machinery Directive 98/37/EC as amended, and with those of the most recent versions of standards EN 60204-1 and EN 292-2 at the least.

According to Annex III of Article 13 of Council Directive 93/68/EEC, amending Council Directive 73/23/EEC concerning electrical equipment designed for use within certain voltage limits, the Gold DC Trombone meets the provisions outlined in Council Directive 73/23/EEC. The party responsible for ensuring that the equipment meets the limits required by EMC regulations is the manufacturer of the end product.

1.5. Warranty Information

The products covered in this manual are warranted to be free of defects in material and workmanship and conform to the specifications stated either within this document or in the product catalog description. All Elmo drives are warranted for a period of 12 months from the time of installation, or 18 months from time of shipment, whichever comes first. No other warranties, expressed or implied — and including a warranty of merchantability and fitness for a particular purpose — extend beyond this warranty.

Chapter 2: Product Description

This installation guide describes the two configurations available for the Gold DC Trombone servo drive. It discusses the wiring, installation and power-up processes for both the EtherCAT and CAN configurations.

Following these guidelines ensures optimal performance of the drive and the system to which it is connected.

2.1. Drive Description

The Gold DC Trombone series of digital servo drives are highly resilient and designed to deliver the highest density of power and intelligence. The Gold DC Trombone delivers up to **10 kW of continuous power** or **16 kW of peak power** in a compact package.

The digital drives are part of Elmo's advanced Gold Line. They operate from a DC power source in current, velocity, position and advanced position modes, in conjunction with a permanent-magnet synchronous brushless motor, DC brush motor, linear motor or voice coil. They are designed for use with any type of sinusoidal and trapezoidal commutation, with vector control. The Gold DC Trombone can operate as a stand-alone device or as part of a multi-axis system in a distributed configuration on a real-time network.

The drives are easily set up and tuned using Elmo Application Studio software tools. This Windows-based application enables users to quickly and simply configure the servo drive for optimal use with their motor. The Gold DC Trombone, as part of the Gold Line, is fully programmable with Elmo's motion control language.

Power to the drives is provided by a DC power source (not included with the Gold DC Trombone).

Since the power stage is fully isolated from the control stage, the DC rectifier can be fed directly from the mains, without the need for a bulky and expensive transformer.

If backup functionality is required to store control parameters in the event of a mains power outage, then an S, T, or AP-model Gold DC Trombone should be used, with an external 24 VDC isolated supply connected to it.

Note: The backup functionality can operate from an isolated voltage source within the range of 18 to 30 VDC.

Whenever backup functionality is not required, Gold DC Trombone models with the 0 or 1 suffix (only for 400 V models) in the catalog number (see page 22) can be used, i.e., they do not have a 24 V control supply. In these models, a smart control-supply algorithm enables the Gold DC Trombone to operate with only the main power supply VP+ and VN-, with no need for a 24 VDC auxiliary power supply for the logic.

The Gold DC Trombone is a stand-alone version of the Gold Trombone module (PCB-mounted). Another pluggable version, the Gold Solo Trombone is also available.

2.2. Product Features

Note: The features described in this chapter relate to the range of Gold DC Trombone models. Depending on the model you have purchased, not all features are available.

To see the features for your model, look at the product label on the Gold DC Trombone and use the product catalog number schematic that appears at the beginning of this manual and on page 22 to determine which specific features are available to you.

2.2.1. Servo Control

- Advanced and extremely fast vector control algorithm (current loop bandwidth: 4 kHz)
- Current/Torque sampling rate: up to 20 kHz (50 µs)
- Velocity sampling rate: up to 10 kHz (100 µs)
- Position sampling rate: up to 10 kHz (100 µs)
- Electrical commutation frequency: up to 4 kHz
- Current closed loop bandwidth exceeds 4 kHz
- Position/Velocity/Acceleration command range – full 32 bit
- Position over velocity, with full dual loop support
- Current gain scheduling to compensate for the motor's non-linear characteristics
- Advanced filtering: Low pass, Notch, General Biquad
- Current loop gain scheduling to compensate for bus voltage variations
- Velocity gain scheduling for ultimate velocity loop performance
- Gains and filter scheduling vs. position for mechanical coupling optimization, speed and position tracking errors
- High order filters gain scheduling vs. speed and position
- S-curve Profile Smoothing
- Cogging, BEMF and ωxL compensation
- Dual Loop Operation supported by Auto Tuning
- Fast, easy and efficient advanced Auto Tuning
- Incremental encoder frequency of up to 75 Megacounts/sec
- Motion profiler numeric range:
  - Position up to ±2 x 10^9 counts
  - Velocity up to 2 x 10^9 counts/sec
  - Acceleration up to 2 x 10^9 counts/sec^2

2.2.2. Motion Control

- Motion control programming environment
- Motion modes: PTP, PT, PVT, ECAM, Follower
- Full DS-402 motion mode support, in both the CANopen and CANopen over EtherCAT (CoE) protocols, including Cyclic Position/Velocity modes. Fast (Hardware) event capturing inputs, supporting < 1 µs latch latency
- Fast (hardware) Output Compare, with < 1 µs latency
- Output compare repetition rate:
  - Fixed Gap: Unlimited
  - Table based: 4 kHz
- Motion Commands: Analog, Pulse-Width Modulation (PWM), Software, Pulse and Direction
- Distributed Motion Control
- EAS (Elmo Application Studio) software: an efficient and user friendly auto tuner

2.2.3. Communications

- Fast and efficient EtherCAT and CANopen networking
- EtherCAT Slave:
  - CoE (CANopen over EtherCAT)
  - EoE (Ethernet over EtherCAT)
  - FoE (File over EtherCAT) for firmware download
  - Supports Distributed Clock
  - EtherCAT cyclic modes supported down to a cycle time of 250 µs
- CANopen (DS-301, DS-305, DS-402)
- Ethernet TCP/IP
  - UDP
  - Telnet
- USB 2.0

2.2.4. Safe Torque Input (STO)

- IEC 61800-5-2, Safe Torque Off (STO)
  - Two STO inputs PLC level which can be configured to 5 V logic
- UL 508C recognition
- UL 60950 compliance
- CE EMC compliance

2.2.5. Outputs

- Four high voltage outputs related to VDD and VDDRET:
  - Conforms to IEC 61131-2
  - Up to 30 VDC
  - High side logic (Source)
  - Low side logic (Sink) - AP
  - Opto-isolated
  - For S, 0 suffix, Digital Outputs 2,3,4 up to 250 mA
  - For AP suffix, Digital Outputs 2,3,4 up to 150 mA
  - For T, 1 suffix, Digital Outputs 2,3,4 up to 7 mA
  - For S, 0 suffix, Digital Output 1 brake output: 500 mA
  - For AP suffix, Digital Output 1 brake output: 300 mA
  - For T, 1 suffix, Digital Output 1: 7 mA
  - Short circuit protection
  - Thermal protection
  - Reverse polarity protection
- Three additional differential outputs can be configured through Port C:
  - EIA-422 differential output line transmitters
  - Response time < 1µs
  - Output current: ± 15 mA

2.2.6. Inputs

- Six Digital Inputs – optically isolated, sharing a single common INRET
- Six Digital Inputs - optically isolated sharing a single common positive supply - AP
- The six digital inputs can be configured to PLC or TTL, depending on the part number definition
- All six inputs are fast capture data <5 µs
- One Analog Input: ±10 V
- Six additional fast differential event capture inputs 5 V logic cab be configured through Ports A and B:
  - Via Port A or B (three on each port, depending on model)
  - EIA-422 Differential input line receiver
  - Response time < 1 µs

2.2.7. Feedback Options

There are Port A and Port B feedback input ports that are flexible and configurable. Each port can be programmed to serve as:

- Commutation feedback and/or
- Velocity feedback and/or
- Position feedback

Port A supports the following sensors, depending on the specific model:

- Incremental encoder
- Incremental encoder and digital Hall
- Absolute serial encoder
- Absolute serial encoder and digital Hall (for dual loop)

Port B supports the following sensors, depending on the specific model:

- Incremental encoder
- Analog encoder
- Analog Hall
- Resolver

Port C is a flexible and configurable feedback output port. It supports the encoder emulation outputs of Port A or Port B or internal variables.

Analog input (±10 V ptp) support:

- Velocity feedback (tachometer)
- Position feedback (potentiometer).

2.2.8. Feedback Sensor Specifications

- Incremental Quadrature Encoder (with or without commutation Halls) up to 75 Megacounts per second (18 MHz PPS (Pulses per Second))
- Digital Hall
  - Up to 4 kHz commutation frequency
  - 5 V logic
  - Input voltage up to 15 VDC
- Incremental encoder and digital Halls
- Analog encoders
  - Supports 1 V PTP Sin/Cos
  - Sin-Cos Frequency: up to 500 kHz
  - Internal Interpolation: up to ×8192
  - Automatic correction of amplitude mismatch, phase mismatch, signal offset

- Analog Halls (commutation & position)
  - One feedback electrical cycle = one motor's electrical cycle
  - Supports 1 V PTP Sin/Cos
  - Sin/Cos Frequency: up to 500 kHz
  - Internal Interpolation: up to ×8192
  - Automatic correction of amplitude mismatch, phase mismatch, signal offset
- Absolute serial encoders:
  - NRZ (Panasonic, Tamagawa, Mitutoyo, etc.)
  - EnDAT 2.2
  - BiSS/SSI
- Resolver up to 512 rps with 14-bit resolution
- Tachometer (available on request)
- Potentiometer (available on request)
- The Gold DC Trombone provides 5 V supply voltage (5 V, 400 mA max) for the encoders supplies

2.2.9. Protection

Built-in Protection & Diagnostics:

- Software error handling
- Abort
- Extensive status reporting
- Protection against:
  - Shorts between motor power outputs and power return
  - Over temperature
  - Over/under voltage
  - Loss of feedback
  - Motor current
  - Current limits
  - Following errors
  - i^2t motor current
- STO

2.3. System Architecture

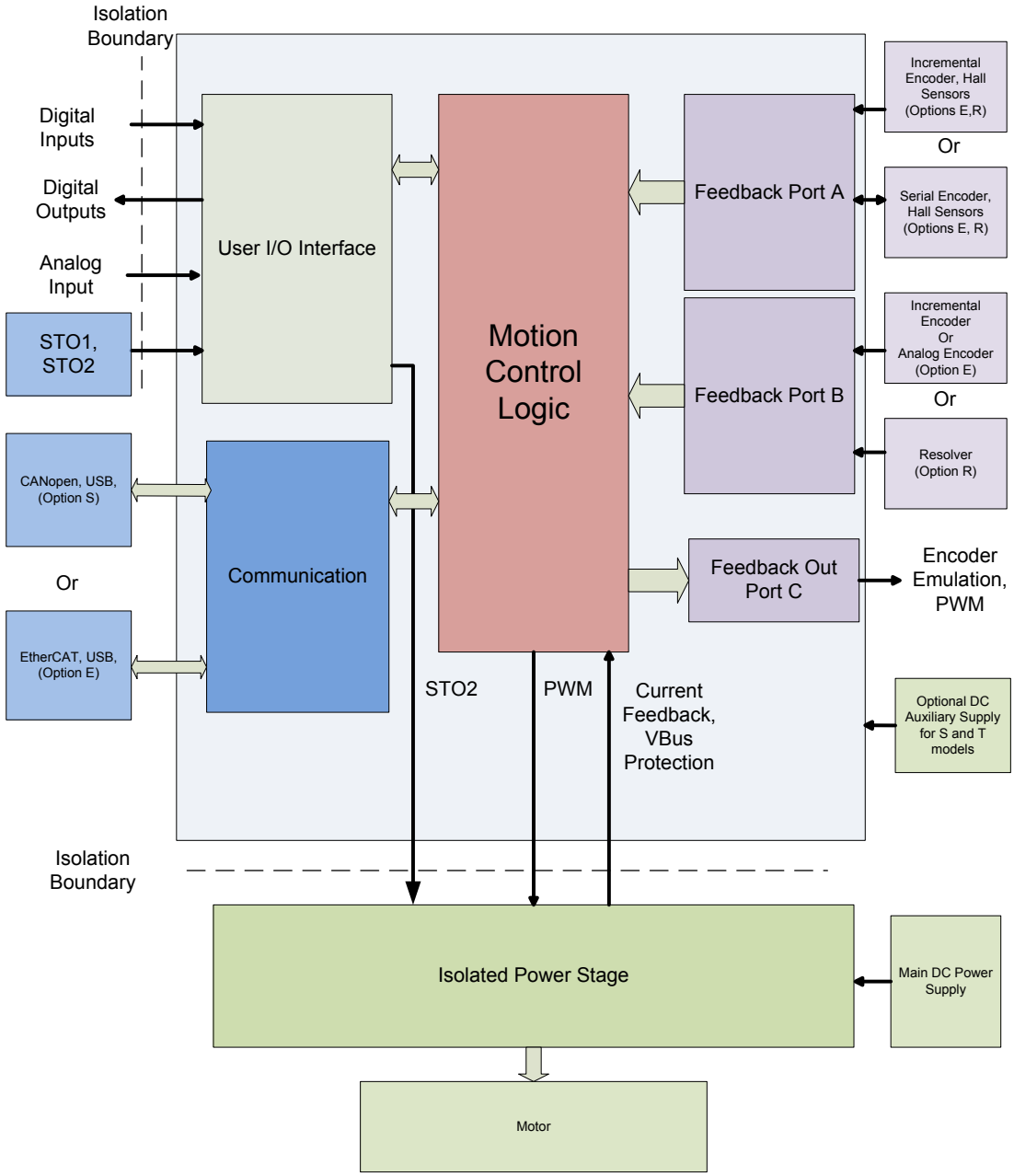


Figure 1: Gold DC Trombone System Block Diagram

2.4. How to Use this Guide

In order to install and operate your Elmo Gold DC Trombone servo drive, you will use this manual in conjunction with a set of Elmo documentation. Installation is your first step; after carefully reading the safety instructions in the first chapter, the following chapters provide you with installation instructions as follows:

- Chapter 3 - *Installation*, provides step-by-step instructions for unpacking, mounting, connecting and powering up the Gold DC Trombone.
- Chapter 4 - *Technical Specifications,* lists all the drive ratings and specifications.

Upon completing the instructions in this guide, your Gold DC Trombone servo drive should be successfully mounted and installed. From this stage, you need to consult higher-level Elmo documentation in order to set up and fine-tune the system for optimal operation.

- The Gold Product Line Software Manual, which describes the comprehensive software used with the Gold DC Trombone
- The Gold Product Line Command Reference Manual, which describes, in detail, each software command used to manipulate the Gold DC Trombone motion controller
- The Elmo Application Studio Software Manual, which includes explanations of all the software tools that are part of the Elmo Application Studio software environment

Chapter 3: Technical Information

3.1. Technical Data

Feature	Units	12/400	16/400	R17/400	R22/400	8/800	12/800	R11/800	R16/800
Minimum supply voltage	VDC	S, T or AP suffix in P/N*: 50 0 or 1 suffix in P/N: 100				S, T or AP suffix in P/N*: 95+			
Nominal supply voltage	VDC	325				560 for 400 VAC 680 for 480 VAC			
Maximum supply voltage	VDC	400				780			
Maximum continuous power output	W	Up to 10 kW of continuous qualitative power							
Efficiency at rated power (at nominal conditions)	%	> 98							
Auxiliary supply voltage option	VDC	18 V to 30 V Only for Control Supply S suffix Model							
Auxiliary power supply	VA	≤5 VA without external loading ≤8 VA with full external loading							
Continuous current limit (Ic) Amplitude sinusoidal/DC trapezoidal commutation	A	12	16	17	22	8	12	11	16
Sinusoidal continuous RMS current limit (Ic)	A	8.5	11.3	12	15.5	5.7	8.5	7.8	11.3
Peak current limit	A	2 x Ic		No peak		2 x Ic		No peak	
Weight	g (oz)	650 g (22.9 oz)							
Dimensions	mm (in)	105 x 140 x 47 (4.13" x 5.51" x 1.85")							
Digital in/Digital out/ Analog in		6/4/1							
Mounting method		Panel / Wall Mounted							

*See page 22 for details on the part number. The S, T, or AP suffix appears in models where there is a 24 V control supply. If there is a 0 or 1 suffix, the control power supply operates from the main power.

Note on current ratings: The current ratings of the Gold DC Trombone are given in units of DC amperes (ratings that are used for trapezoidal commutation or DC motors). The RMS (sinusoidal commutation) value is the DC value divided by 1.41.

3.1.1. Auxiliary Supply

Feature	Details
Auxiliary power supply	*Isolated DC source only*
Auxiliary supply input voltage	18 VDC to 30 VDC
Auxiliary supply input power	< 4 VA (this includes the 5 V/200 mA load for the main encoder only) < 5.5 VA (this includes the 5 V/400 mA load on the main encoder and feedback B)

Chapter 4: Installation

The Gold DC Trombone must be installed in a suitable environment and properly connected to its voltage supplies and the motor.

4.1. Site Requirements

You can guarantee the safe operation of the Gold DC Trombone by ensuring that it is installed in an appropriate environment.

Feature	Value
Ambient operating temperature	0 °C to 40 °C (32 °F to 104 °F)
Maximum non-condensing humidity	90%
Maximum Altitude	10,000 m
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	

Caution: The Gold DC Trombone dissipates its heat by convection. The maximum ambient operating temperature of 40 °C (104 °F) must not be exceeded.

4.2. Unpacking the Drive Components

Before you begin working with the Gold DC Trombone, verify that you have all of its components, as follows:

- The Gold DC Trombone servo drive
- The Elmo Application Studio (EAS) software and software manual

The Gold DC Trombone is shipped in a cardboard box with Styrofoam protection.

To unpack the Gold DC Trombone:

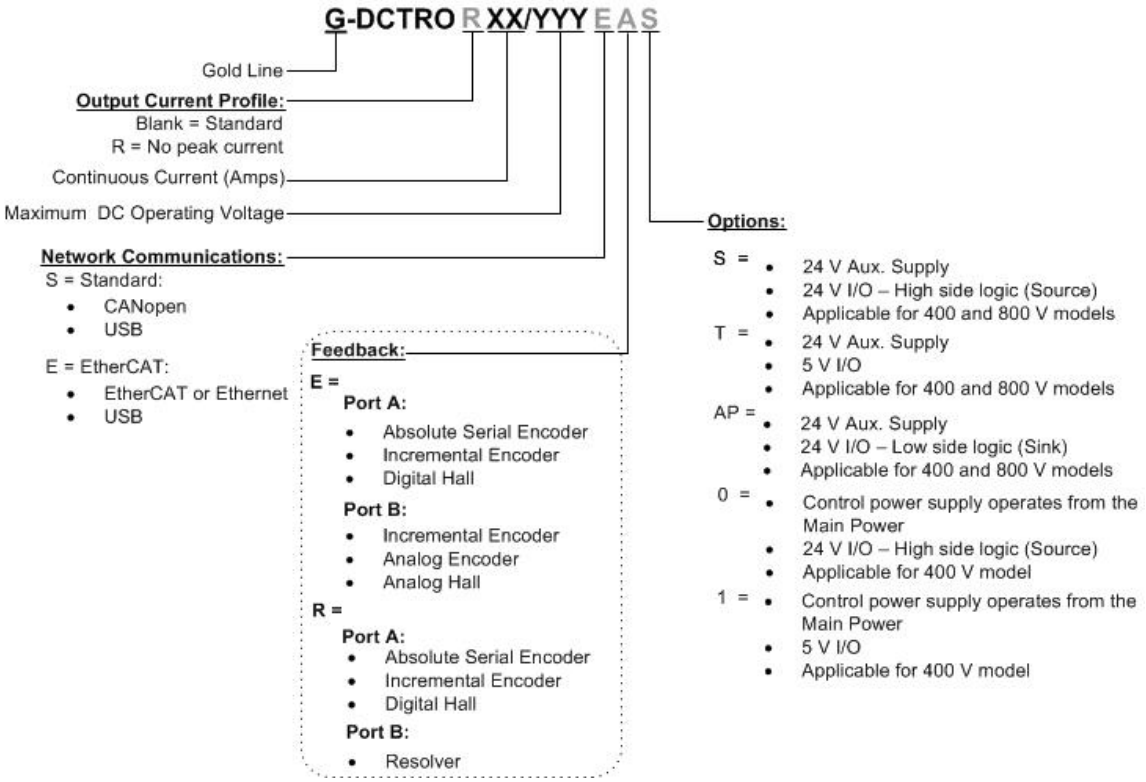
1. Carefully remove the servo drive from the box and the Styrofoam.
2. Check the drive to ensure that there is no visible damage to the instrument. If any damage has occurred, report it immediately to the carrier that delivered your drive.

3. To ensure that the Gold DC Trombone you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Gold DC Trombone. It looks like this:

Figure 2: Gold DC Trombone Part Number Sticker

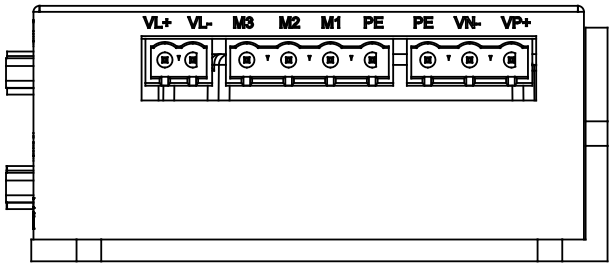
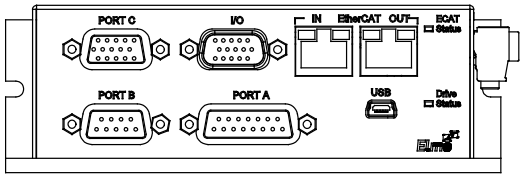
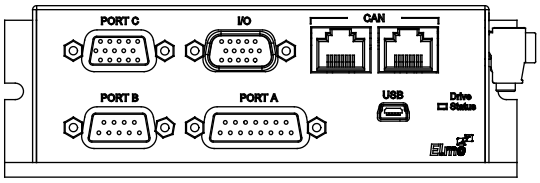
4. Verify that the Gold DC Trombone type is the one that you ordered, and ensure that the voltage meets your specific requirements.

   The part number at the top gives the type designation as follows:



4.3. Connector Types

The Gold DC Trombone has 10 connectors of the following types:

Pins	Type	Function
Bottom Connectors		
 GTRODC004B		
2	5.08 mm Phoenix high current	24 V
4	7.62 mm Phoenix high current	Motor Connector
3	7.62 mm Phoenix high current	Power Connector
Front Connectors		
 GTRODC051C **Front Connectors - EtherCAT**  GTRODC064A **Front Connectors - CAN**		
15	Socket D-Type	Port A
9	Socket D-Type	Port B
15	Socket High Density D-Type	Port C and Safety
15	Pin High Density D-Type	I/O
4	USB Device Type Mini B	USB communication
EtherCAT Version		
8	RJ-45	Ethernet/EtherCAT_IN communication
8	RJ-45	EtherCAT OUT communication

CAN Version		
8	RJ-45	CAN in
8	RJ-45	CAN out

Table 1: Connector Types

4.3.1. Pinouts

The pinouts in this section describe the function of each pin in the Gold DC Trombone connectors that are listed in Table 1.

4.3.1.1. Motor Power Connector

See Section 4.7.1 for full details.

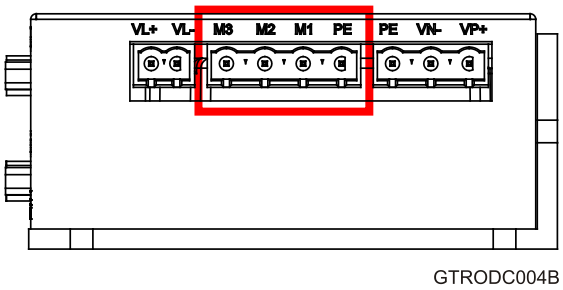
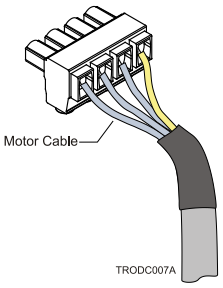
Pin	Function	Cable	
		Brushless Motor	Brushed DC Motor
M3	Motor phase	Motor	Motor
M2	Motor phase	Motor	Motor
M1	Motor phase	Motor	N/C
PE	Protective Earth	Motor	Motor
 GTRODC004B **4-Pin Pluggable 7.62 mm Phoenix High Current**			 **4-Pin Phoenix Plug-in Connector**

Table 2: Connectors for Motor

4.3.1.2. Main Power Connector

See Section 4.7.2 for full details.

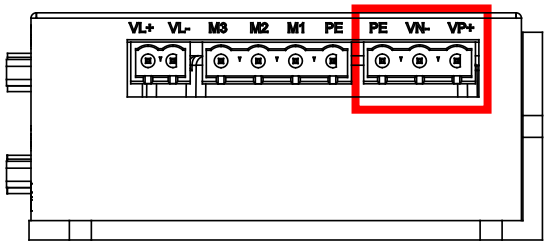
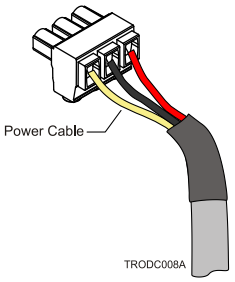
Pin	Function	Cable
PE	Protective Earth	DC Power
VN-	DC Negative Power input	DC Power
VP+	DC Positive Power input	DC Power
 GTRODC004B **3-Pin Pluggable 7.62 mm Phoenix High Current**		 **3-Pin Phoenix Plug-in Connector**

Table 3: Connectors for Main Power

4.3.1.3. Auxiliary Power Connector

See Section 4.7.3 for full details.

Optional Backup Supply in S, T, or AP suffix drives.

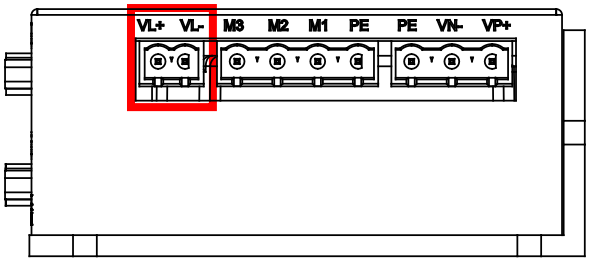
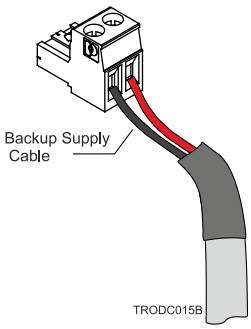
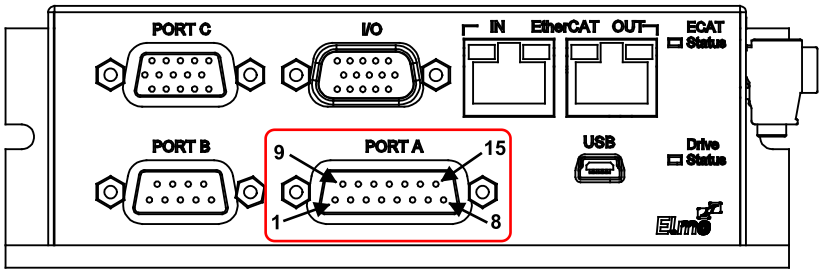
Pin	Function	Cable
S, T, or AP suffix type		
VL+	+24 V Auxiliary Supply Input Positive	DC Power
VL-	24 V RET Auxiliary Supply Input Return	DC Power
 GTRODC004B **2-Pin Pluggable 5.08 mm Phoenix High Current**		 **2-Pin Phoenix Plug-in Connector**

Table 4: Auxiliary Power Connector

4.3.1.4. Port A Connector

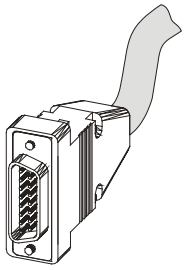
See Section 4.9.1 for full details.

Incremental Encoder			Absolute Serial Encoder	
Pin on Port A	**Signal**	**Function**	**Signal**	**Function**
12,4	+5V	Encoder +5V supply	+5V	Encoder +5V supply
3,9,11,13	SUPRET	Common return	SUPRET	Supply return
6	PortA_ENC_A+	Channel A+	ABS_CLK+	Abs encoder clock +
5	PortA_ENC_A-	Channel A-	ABS_CLK-	Abs encoder clock -
15	PortA_ENC_B+	Channel B+	ABS_DATA+	Abs encoder data +
14	PortA_ENC_B-	Channel B-	ABS_DATA-	Abs encoder data -
8	PortA_ENC_INDEX+	Index+	Reserved	Reserved
7	PortA_ENC_INDEX-	Index-	Reserved	Reserved
2	HA	Hall sensor A	HA	Hall sensor A
10	HB	Hall sensor B	HB	Hall sensor B
1	HC	Hall sensor C	HC	Hall sensor C
Pin Positions				



GTRODC003B

15-Pin D-Type Female Connector



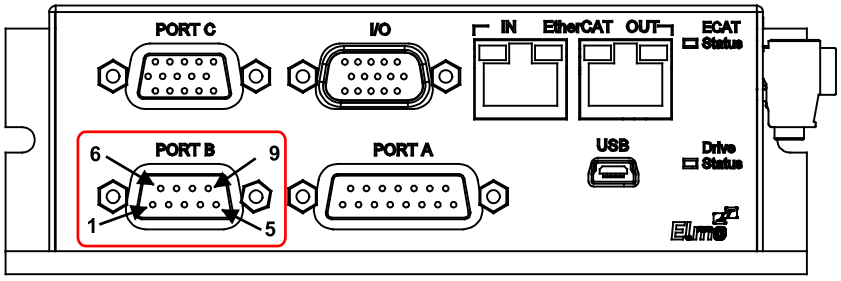
15-Pin D-Type Male Connector

Table 5: Port A Pin Assignments

4.3.1.5. Port B Connector

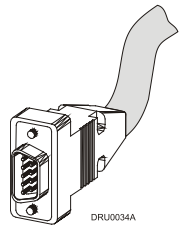
See Section 4.9.2 or full details.

	Incremental or Interpolated Analog Encoder		Resolver	
	G-DCTROXX/YYYYEX		G-DCTROXXX/YYYYRX	
Pin on Port B	**Signal**	**Function**	**Signal**	**Function**
4	+5V	Encoder +5V supply	NC	
5,9	SUPRET	Supply return	SUPRET	Supply return
1	PortB_ENC_A+/SIN+	Incremental Encoder A+ / Sine+	SIN+	Sine+
6	PortB_ENC_A-/SIN-	Channel A- / Sine-	SIN-	Sine-
2	PortB_ENC_B+/COS+	Channel B+ / Cosine+	COS+	Cosine+
7	PortB_ENC_B-/COS-	Channel B- / Cosine-	COS-	Cosine-
3	PortB_ENC_INDEX+	Index+	RESOLVER_OUT+	Vref f=1/TS, 50 mA Max.
8	PortB_ENC_INDEX-	Index -	RESOLVER_OUT-	Vref complement f= 1/TS, 50 mA Max.
Pin Positions				



GTRODC048C

9-Pin D-Type Female Connector



9-Pin D-Type Male Connector

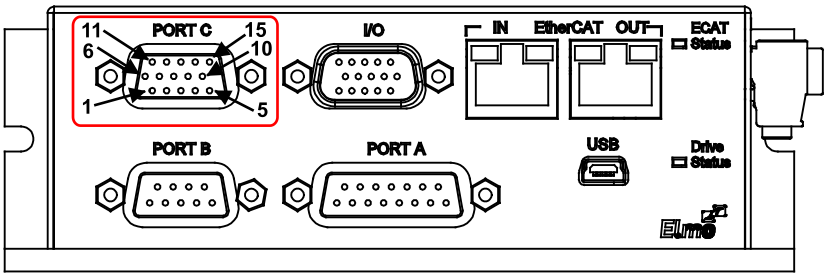
Table 6: Port B Pin Assignments

4.3.1.6. Port C Connector

The Port C connector includes the following functions:

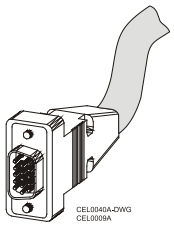
- Port C: For full details see Section 4.9.3.
- STO: For full details see Section 4.8.
- Analog input: For full details see Section 4.10.2.

Pin on Port C	Signal	Function
1	PortC_ENCO_A+	Buffered Channel A+ output/Pulse+/PWM+
2	PortC_ENCO _A-	Buffered Channel A- output / Pulse- / PWM-
3	PortC_ENCO _B+	Buffered Channel B+ output / Dir+
4	PortC_ENCO _B-	Buffered Channel B- output / Dir-
5	PortC_ENCO _ Index+	Buffered Channel INDEX+ output
6	STO1	STO 1 input (default 24 V)
7, 12	STO_RET	STO signal return
8	Reserved	Reserved
9	COMRET	Common return
10	PortC_ENCO _ Index-	Buffered Channel INDEX- output
11	STO2	STO 2 input (default 24 V)
13	ANLRET	Analog ground
14	ANALOG1-	Analog input 1-
15	ANALOG1+	Analog input 1+
Pin Positions		



GTRODC050C

15-Socket High Density D-Type Connector



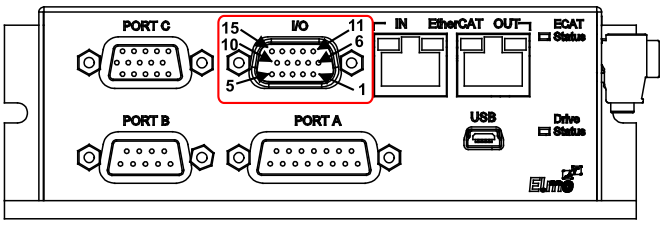
15-Pin High Density D-Type Male Connector

Table 7: Port C Feedback Out and STO Analog In

4.3.1.7. I/O Connector

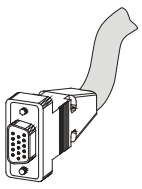
See Section 4.10 for full details on I/O.

Pin on I/O	Signal	Function
1	IN1	High speed programmable input 1 (event capture, home, general purpose, RLS, FLS, INH, PWM & direction input, pulse & direction input)
2	IN2	High speed programmable input 2 (event capture, home, general purpose, RLS, FLS, INH, PWM & direction input, pulse & direction input)
7	IN3	High speed programmable input 3 (event capture, home, general purpose, RLS, FLS, INH, PWM & direction input, pulse & direction input)
8	IN4	High speed programmable input 4 (event capture, home, general purpose, RLS, FLS, INH, PWM & direction input, pulse & direction input)
11	IN5	High speed programmable input 5 (event capture, home, general purpose, RLS, FLS, INH, PWM & direction input, pulse & direction input)
12	IN6	High speed programmable input 6 (event capture, home, general purpose, RLS, FLS, INH, PWM & direction input, pulse & direction input)
6	INRET1-6	Programmable inputs 1 - 6 return for standard version Programmable positive inputs 1 - 6 for AP version
3	OUT1	Programmable output 1
4	OUT2	Programmable output 2
5	OUT3	Programmable output 3
13	OUT4	Programmable output 4
10, 15	VDD	Supply for out 1-4
9, 14	VDDRET	Supply return for out 1-4
Pin Positions		



GTRODC049C

15-Pin High Density D-Type Male Connector



15-Pin High Density D-Type Female Connector

Table 8: I/O Connector Pin Assignments

4.3.1.8. USB

See Section 4.11.1 for the electrical diagram.

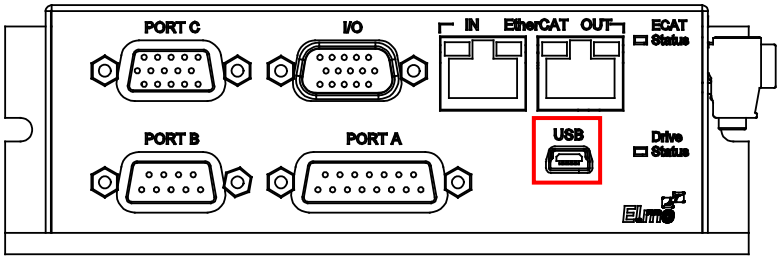
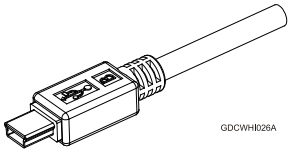
Pin on USB	Signal	Function
1	USB VBUS	USB VBUS 5V
2	USBD-	USB _N line
3	USBD+	USB _P line
5	USB COMRET	USB communication return
Pin Positions		
 GTRODC051C		 **USB Device Mini B Plug**

Table 9: USB 2.0 Pin Assignments

4.3.2. EtherCAT Communications Version

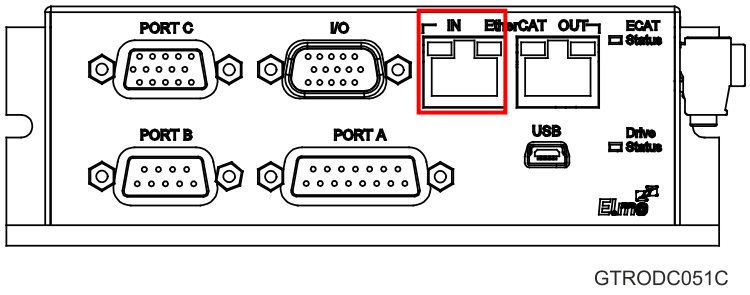
Fieldbus communications are industrial network protocols for real-time distributed control that allows connection of servo drives. The Gold DC Trombone supports the following EtherCAT fieldbus type industrial network protocol:

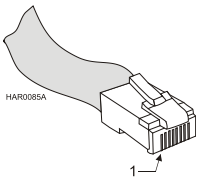
Fieldbus Type	Product Number
EtherCAT	G-DCTRO XX/YYYEXX

4.3.2.1. EtherCAT In/Ethernet

See Section 4.11.2 for the electrical diagram.

Pin	Signal	Function
1	EtherCAT_IN_TX+	EtherCAT in transmit +
2	EtherCAT_IN_TX-	EtherCAT in transmit -
3	EtherCAT_IN_RX+	EtherCAT in receive +
4/5	N/A	
6	EtherCAT_IN_RX-	EtherCAT in receive -
7/8	N/A	
Pin Positions		





Standard CAT5e Ethernet Cable

Table 10: EtherCAT In Connector Pin Assignments

4.3.2.2. EtherCAT Out

See Section 4.11.2 for the electrical diagram.

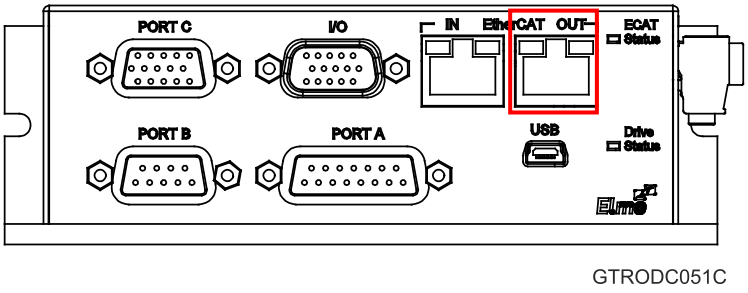
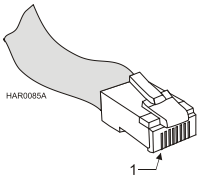
Pin	Signal	Function
1	EtherCAT_OUT_TX+	EtherCAT out transmit +
2	EtherCAT_OUT_TX-	EtherCAT out transmit -
3	EtherCAT_OUT_RX+	EtherCAT out receive +
4/5	N/A	
6	EtherCAT_OUT_RX-	EtherCAT out receive -
7/8	N/A	
Pin Positions		
		 **Standard CAT5e Ethernet Cable**

Table 11: EtherCAT Out Connector Pin Assignments

4.3.2.3. EtherCAT Link Indicators

This section is only relevant for EtherCAT (P/N G-DCTRO XX/YYYEXX) products only.

The Gold DC Trombone can serve as an EtherCAT slave device. For this purpose it has two RJ-45 connectors, which are designated as EtherCAT In and EtherCAT Out. Each of these RJ-45 connectors has two status LEDs, which are shown in Figure 3.

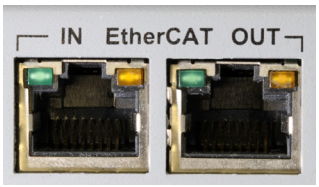


Figure 3: Ethernet Connector LEDs

The green LED is the link/activity indicator. It shows the state of the applicable physical link and the activity on that link.

The amber LED is the speed indicator. It shows the speed of the connection on the Ethernet line.

The possible states of these LEDs are summarized in Table 13.

LED	State	Meaning
Link /Activity	Off	No link is established.
	On	A link is established.
	Blinking	There is data transmission activity.
Speed	On	The connection speed is 100 Mbps. The speed of the EtherCAT line must be 100 Mbps. Otherwise, there is no EtherCAT data transmission.
	Off	The connection speed is 10 Mbps.

Table 12: LED States

4.3.2.4. EtherCAT Status Indicator

The EtherCAT status indicator is a red/green dual LED. It combines run indication (when it is green) and error indication (when it is red) of the EtherCAT device.

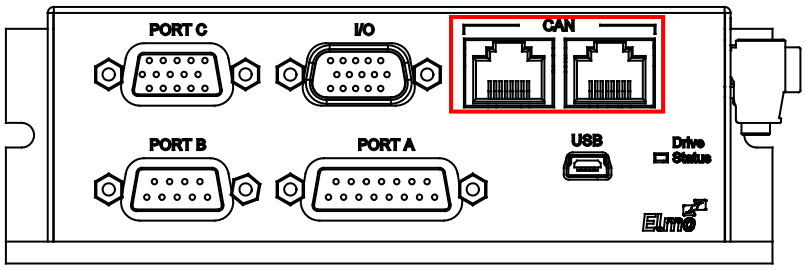
4.3.3. CAN Communications Version

Fieldbus communications are industrial network protocols for real-time distributed control that allows connection of servo drives. The Gold DC Trombone supports the following CAN fieldbus type industrial network protocol:

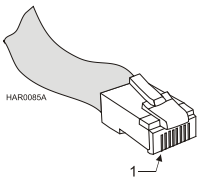
Fieldbus Type	Product Number
CAN	G-DCTRO XX/YYYSXX

See Section 4.11.4 for the electrical diagram.

Pin	Signal	Function
1	CAN_H	CAN_H bus line (dominant high)
2	CAN_L	CAN_L bus line (dominant low)
3	CAN_RET	CAN Return
4, 5	N/A	—
6	CAN_SHLD	Shield, connected to the RJ plug cover
7	CAN_RET	CAN Return
8	N/A	—
Pin Positions		



GTRODC064A



Standard CAT5e Ethernet Cable

Table 13: CAN In/Out Connectors Pin Assignments

4.3.4. Drive Status Indicator

The Gold DC Trombone is equipped with several light-emitting diode (LED) indicators.

The red/green dual LED is used for immediate indication of the following states:

- **Initiation state:** In this state the LED indicates whether the drive is in the boot state (blinking red) or in the operational state (steady red).
- **Working state:** In this state the LED indicates whether the drive is in an amplifier failure state (red) or is ready to enable the motor (green).

4.4. Mounting the Gold DC Trombone

The Gold DC Trombone has been designed for two standard mounting options:

- Wall Mount along the back (can also be mounted horizontally on a metal surface)
- Book Shelf along the side

M4 round head screws, one through each opening in the heat sink, are used to mount the Gold DC Trombone (see the diagram below).

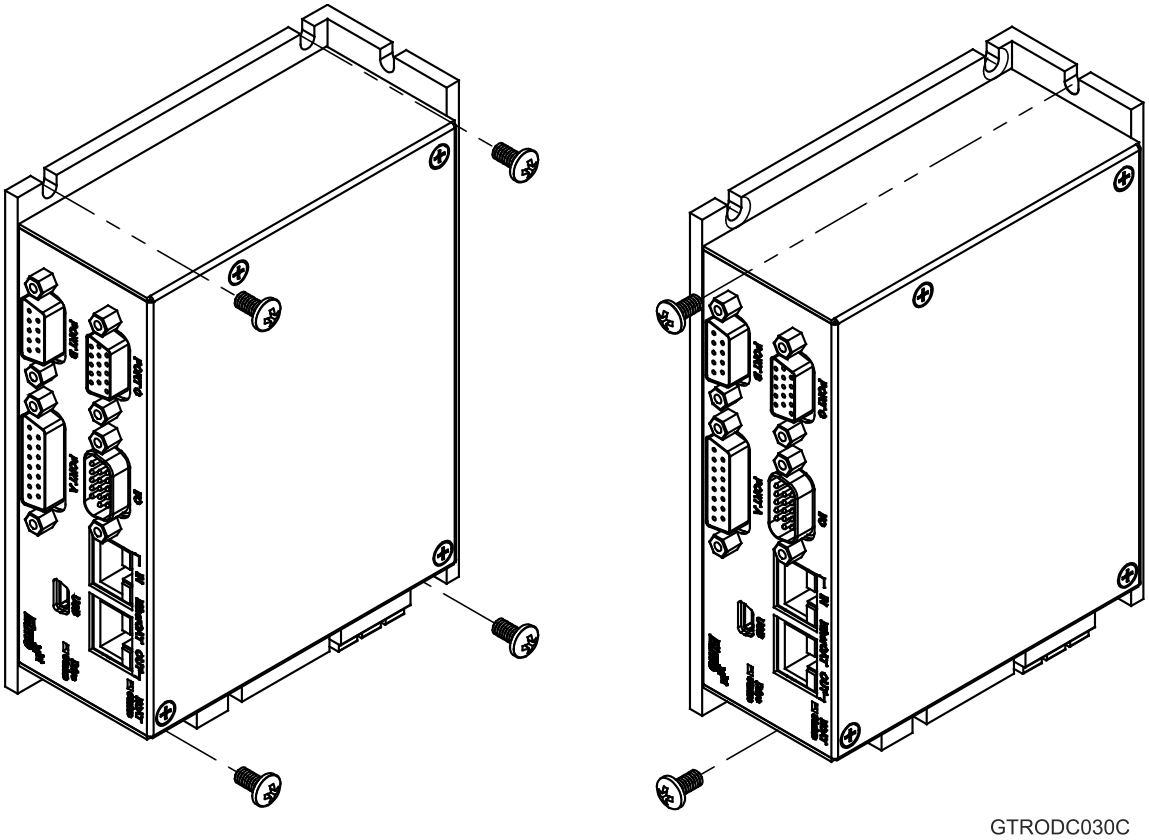


Figure 4: Mounting the Gold DC Trombone

4.5. Wiring the Gold DC Trombone

Once the Gold DC Trombone is mounted, you are ready to wire the device. Proper wiring, grounding and shielding are essential for ensuring safe, immune and optimal servo performance of the Gold DC Trombone.

Caution: Perform the following instructions to ensure safe and proper wiring.

1. Use twisted pair shielded cables for control, feedback and communication connections. For best results, the cable should have an aluminum foil shield covered by copper braid, and should contain a drain wire.
2. The drain wire is a non-insulated wire that is in contact with parts of the cable, usually the shield. It is used to terminate the shield and as a grounding connection.

3. The impedance of the wire must be as low as possible. The size of the wire must be thicker than actually required by the carrying current. A 24, 26 or 28 AWG wire for control and feedback cables is satisfactory although 24 AWG is recommended.
4. Use shielded wires for motor connections as well. If the wires are long, ensure that the capacitance between the wires is not too high: C < 30 nF is satisfactory for most applications.
5. Keep all wires and cables as short as possible.
6. Keep the motor wires as far away as possible from the feedback, control and communication cables.
7. Ensure that in normal operating conditions, the shielded wires and drain *carry no current.* The only time these conductors carry current is under abnormal conditions, when electrical equipment has become a potential shock or fire hazard while conducting external EMI interferences directly to ground, in order to prevent them from affecting the drive. Failing to meet this requirement can result in drive/controller/host failure.
8. After completing the wiring, carefully inspect all wires to ensure tightness, good solder joints and general safety.

4.6. Connection Diagrams

There are two connection diagrams for EtherCAT and two for CAN that show the two different ways of connecting the power supply:

- 400 V and 800 V S, T, or AP models (the catalog number has an S, T, or AP suffix) that feature backup functionality and require an auxiliary 24 V backup supply. The drive will not be operative without the external 24 VDC supply.
- 400 V model without backup functionality with a 0 or 1 suffix. The drive's internal DC/DC converter is fed from the VP+ and VN- of the internal drive's bus line.

4.6.1. Connection Diagrams for EtherCAT Version

The following describes the connection diagrams for the EtherCAT version.

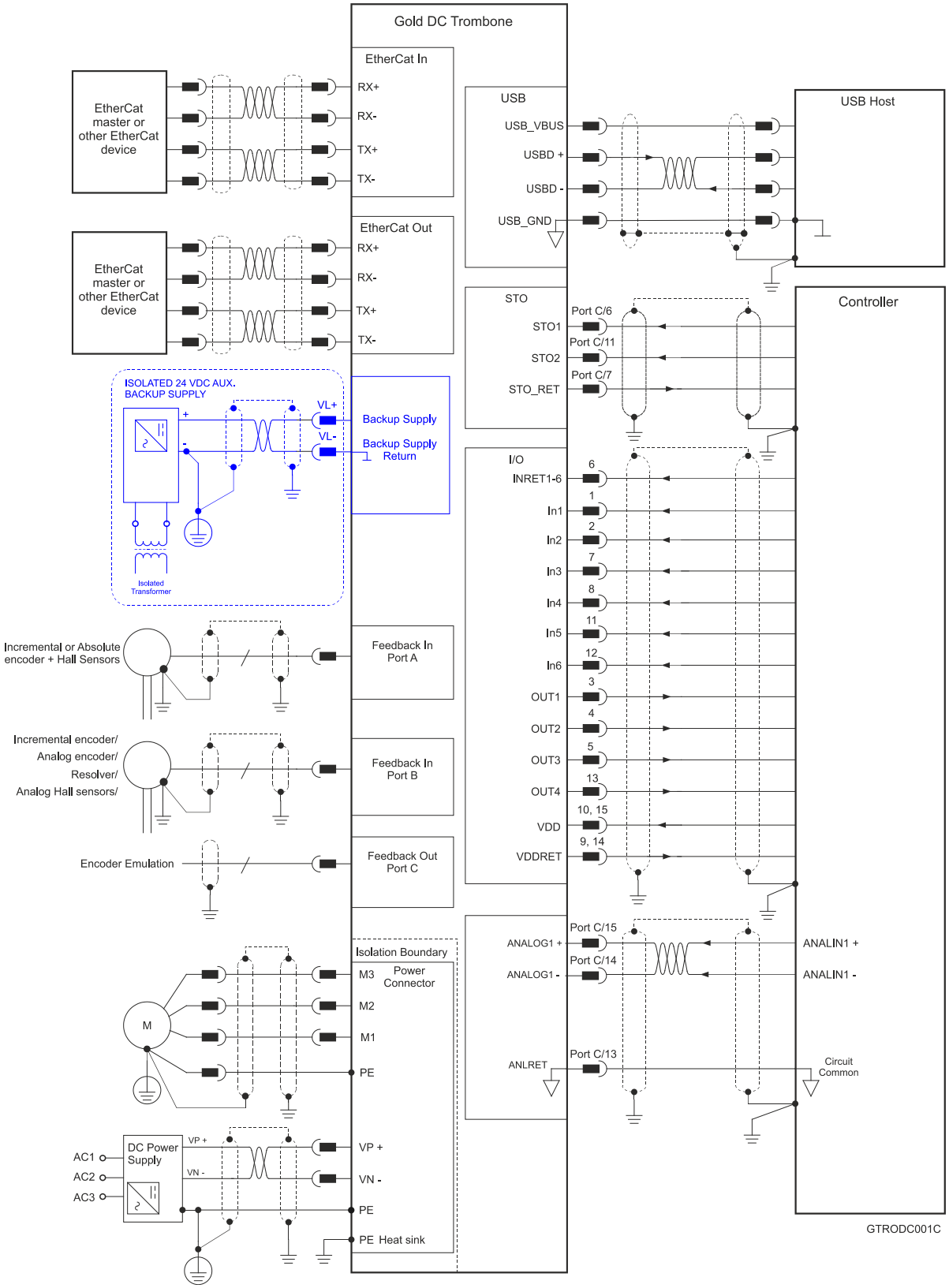


Figure 5: Gold DC Trombone EtherCAT Connection Diagram – with Backup Functionality (S, T, or AP Model Drive)

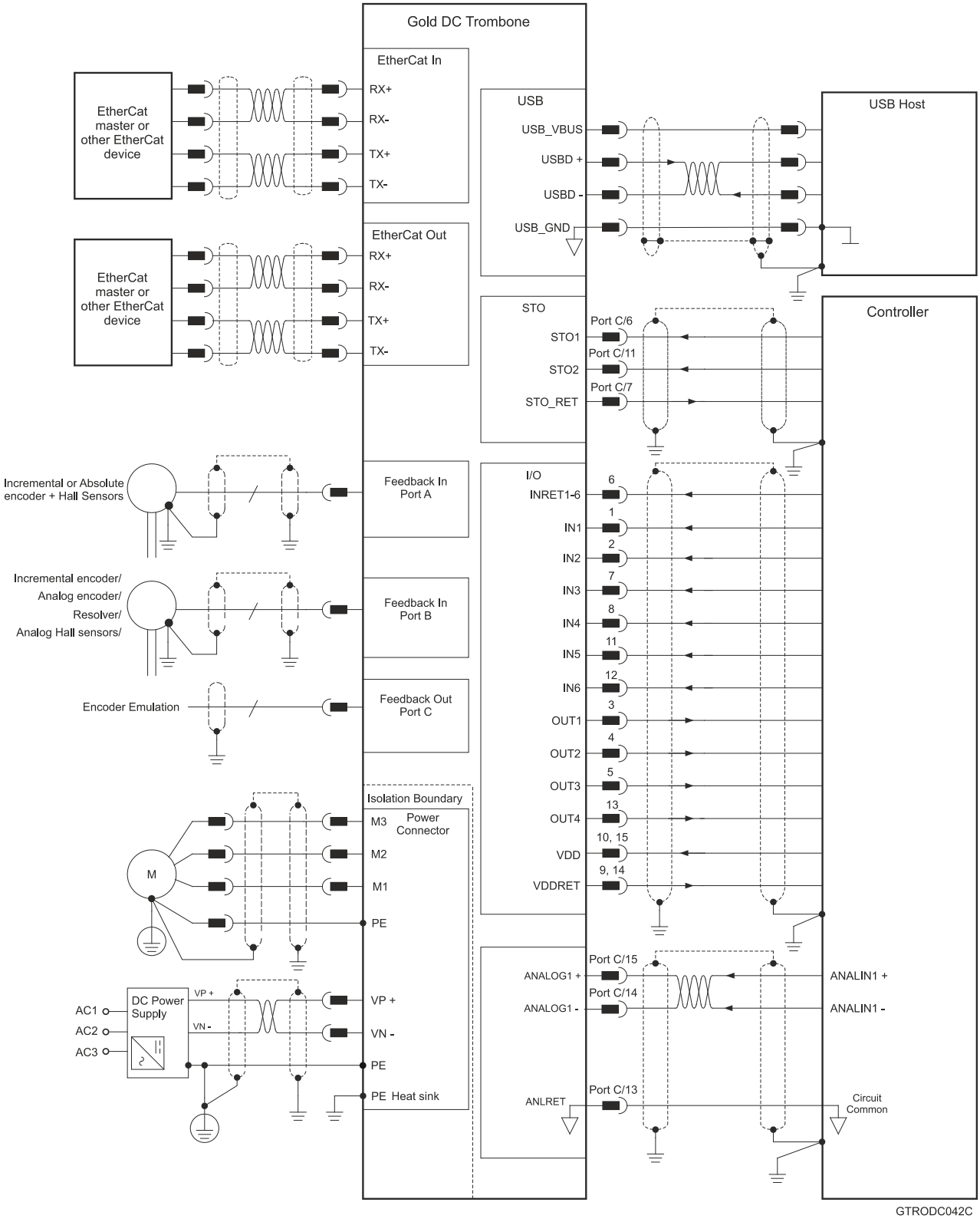


Figure 6: Gold DC Trombone EtherCAT Connection Diagram – 400 V without Backup Functionality for Model Drives with 0 or 1 Suffixes

4.6.2. Connection Diagrams for CAN Version

The following describes the connection diagrams for the CAN version.

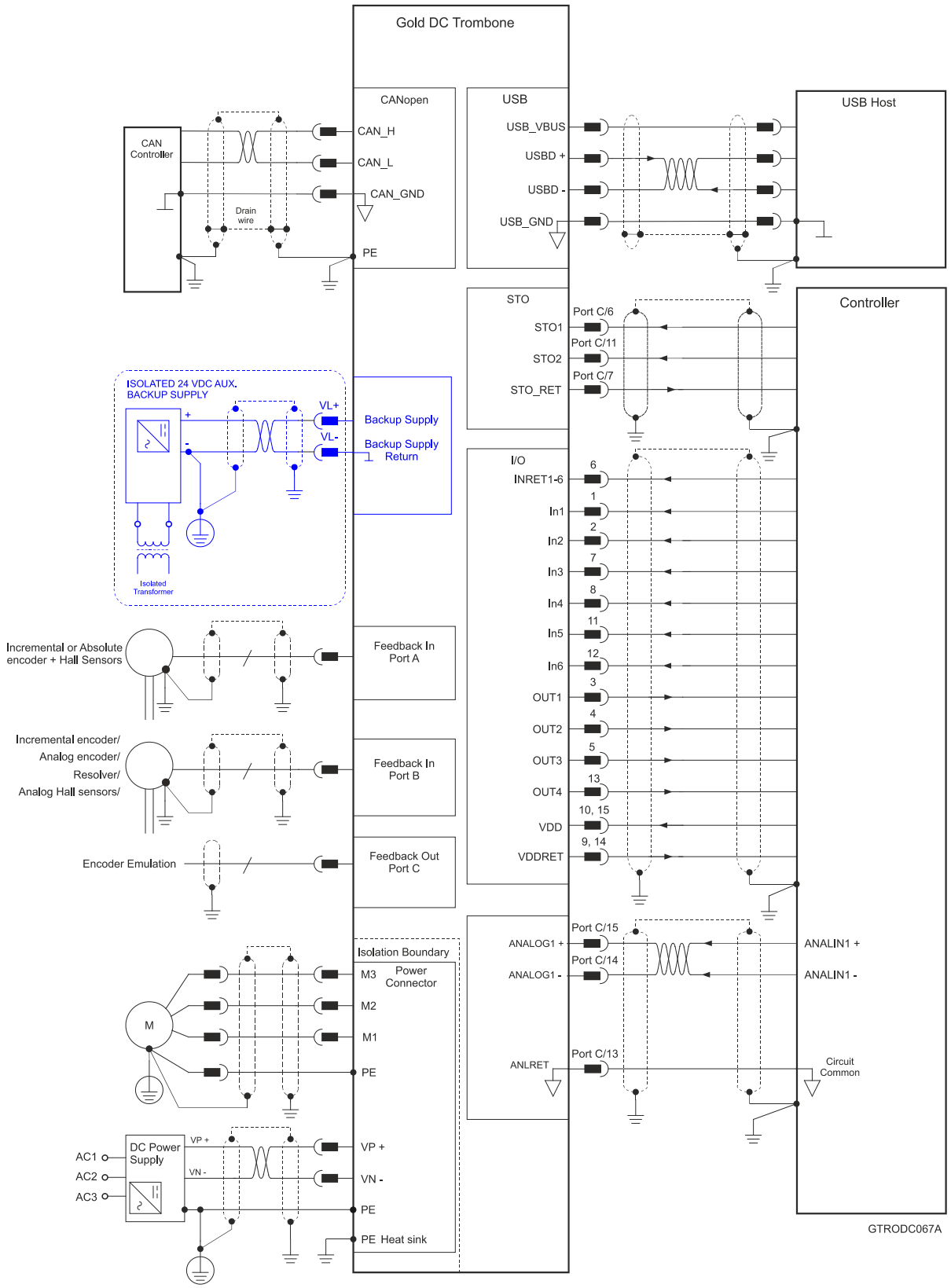


Figure 7: Gold DC Trombone CAN Connection Diagram – with Backup Functionality (S, T, or AP Model Drive)

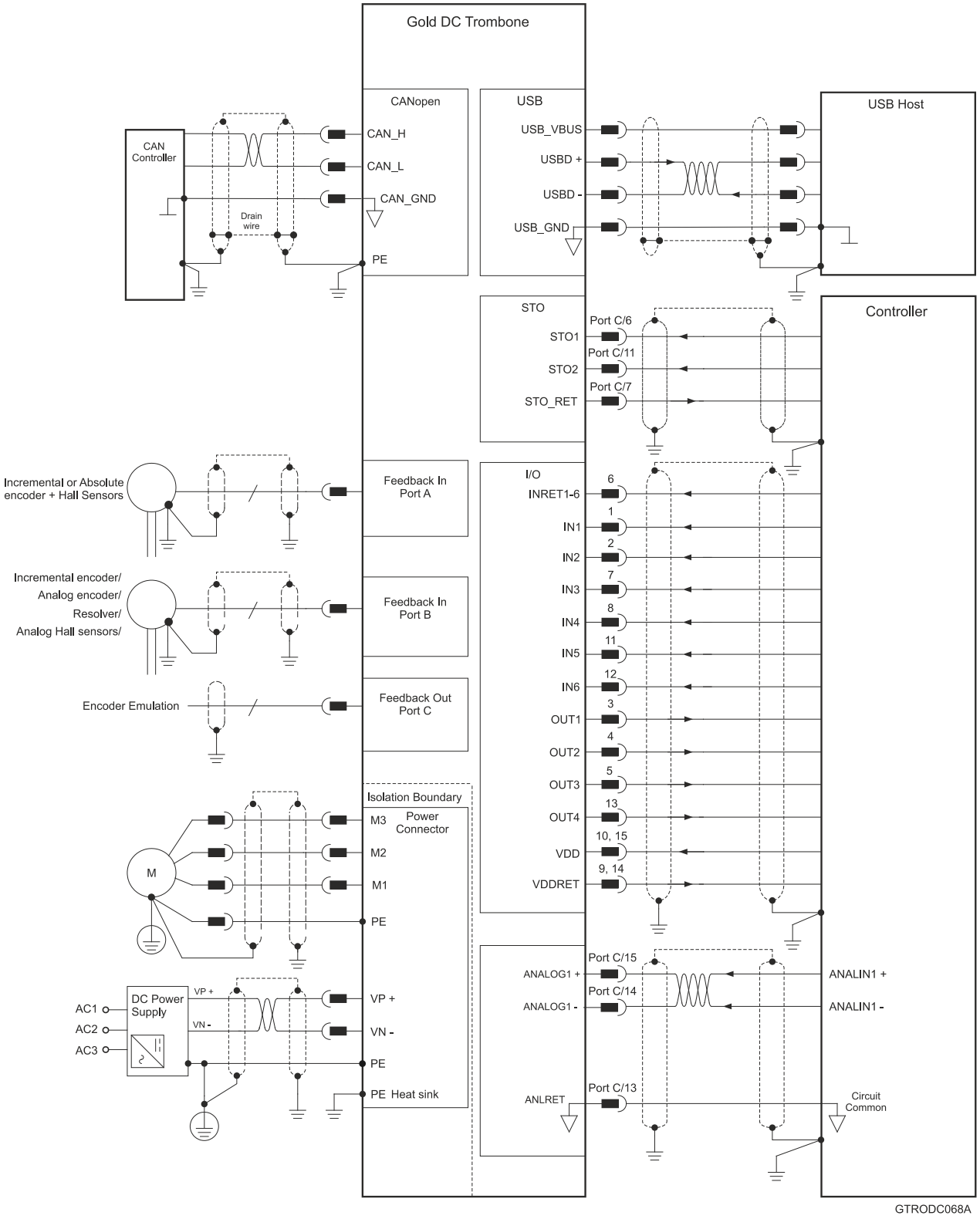


Figure 8: Gold DC Trombone CAN Connection Diagram – 400 V without Backup Functionality for Model Drives with 0 or 1 Suffixes

4.7. Main Power, Auxiliary Power and Motor Power

The Gold DC Trombone receives power from main and auxiliary supplies and delivers power to the motor.

4.7.1. Motor Power

Pin	Function	Cable	
		Brushless Motor	**Brushed DC Motor**
M3	Motor phase	Motor	Motor
M2	Motor phase	Motor	Motor
M1	Motor phase	Motor	N/C
PE	Protective Earth	Motor	Motor

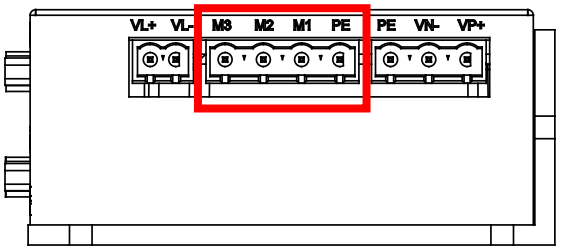


Table 14: Connector for Main Power and Motor

Connect the M1, M2, M3 and PE pins on the Gold DC Trombone. The phase connection is arbitrary as Elmo Application Studio (EAS) will establish the proper commutation automatically during setup. When tuning a number of drives, you can copy the setup file to the other drives and thus avoid tuning each drive separately. In this case the motor-phase order must be the same as on the first drive.

Notes:

- For best immunity, it is highly recommended to use a 4-wire shielded (not twisted) cable for the motor connection. The gauge is determined by the actual current consumption of the motor.
- Connect the cable shield to the closest ground connection at the motor end.
- Connect the cable shield to the closest PE terminal of the Gold DC Trombone.
- Ensure that the motor chassis is properly grounded.

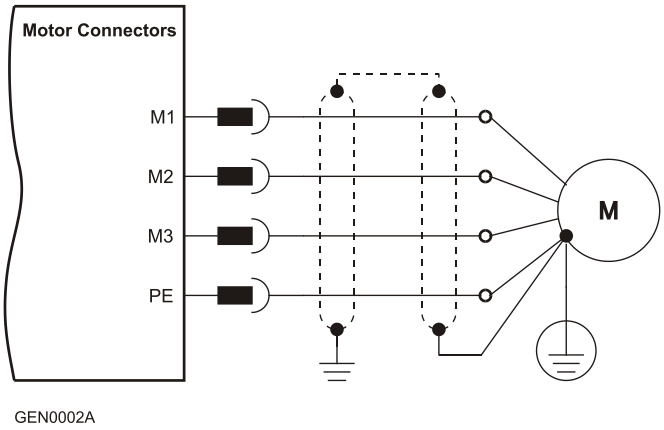


Figure 9: Brushless Motor Power Connection Diagram

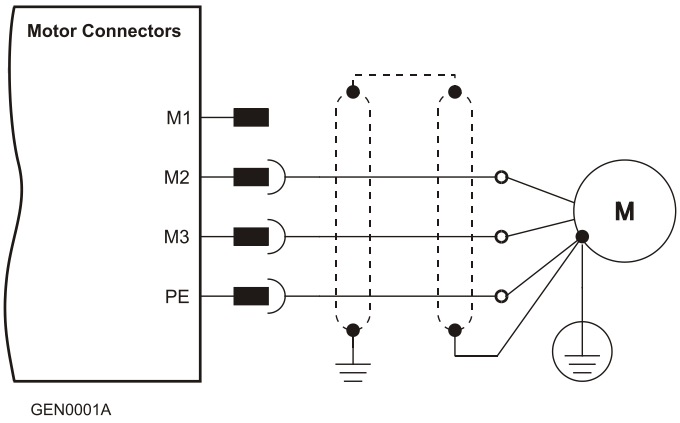


Figure 10: DC Brushed Motor Power Connection Diagram

4.7.2. Main Power

Pin	Function	Cable
PE	Protective Earth	DC Power
VN-	DC Negative Power input	DC Power
VP+	DC Positive Power input	DC Power

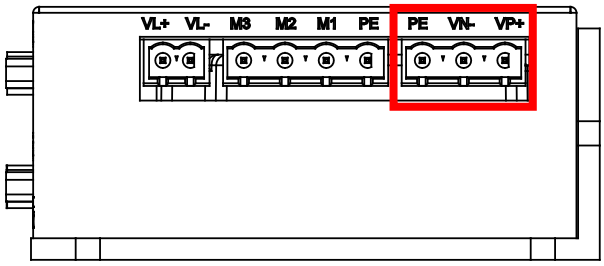


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Table 15: Connectors for Main Power

The DC power for the Gold DC Trombone is delivered from a separated rectifying unit (supplied by the user). Elmo recommends using the Tambourine rectifier specifically designed for use with Elmo drives which offers a range of versatile options.

The following sections contain topology recommendations for implementing three-phase and a single-phase supply chains.

The power stage of the Gold DC Trombone is fully isolated from the other sections of the Gold DC Trombone, such as the control-stage and the heat sink. This isolation allows the user to connect the common of the control section to the PE, a connection which significantly contributes to proper functionality, safety and EMI immunity, leading to better performance of the Gold DC Trombone.

In addition, this isolation simplifies the requirements of the DC power supply that is used to power the DC bus of the Gold DC Trombone, by allowing it to operate with a non-isolated DC power source (a direct-to-mains connection) which eliminates the need for a bulky and expensive isolation transformer.

However, as well as operating from a non-isolated/direct-to-mains DC power supply, the Gold DC Trombone can also operate from an isolated power supply or batteries.

When rectifying an AC voltage source, the AC voltage level must be limited to 270 VAC so as not to exceed the maximum 390 VDC in the case of a 400 VDC drive, or 528 VAC so as not to exceed the maximum 747 VDC in the case of an 800 VDC drive.

4.7.2.1. Direct-to-Mains Power Source (Non-Isolated Rectifier)

This section relates to the configuration of the power supply and drive, which are connected directly to the mains.

To connect the non-isolated DC power supply:

1. For best immunity, it is highly recommended to use twisted cables for the DC power supply cable. A 3-wire shielded cable should be used. The gauge is determined by the actual current consumption of the motor.
2. Connect both ends of the cable shield to the closest PE connections.
3. Tie one end to the power supply's PE terminal, and tie the other end either to the PE pins of the module/PE terminal of the integration board, or attach it to one of the four mounting screws of the drive's heat sink.

4.7.2.1.a Three-Phase Direct-to-Mains Connection Topology

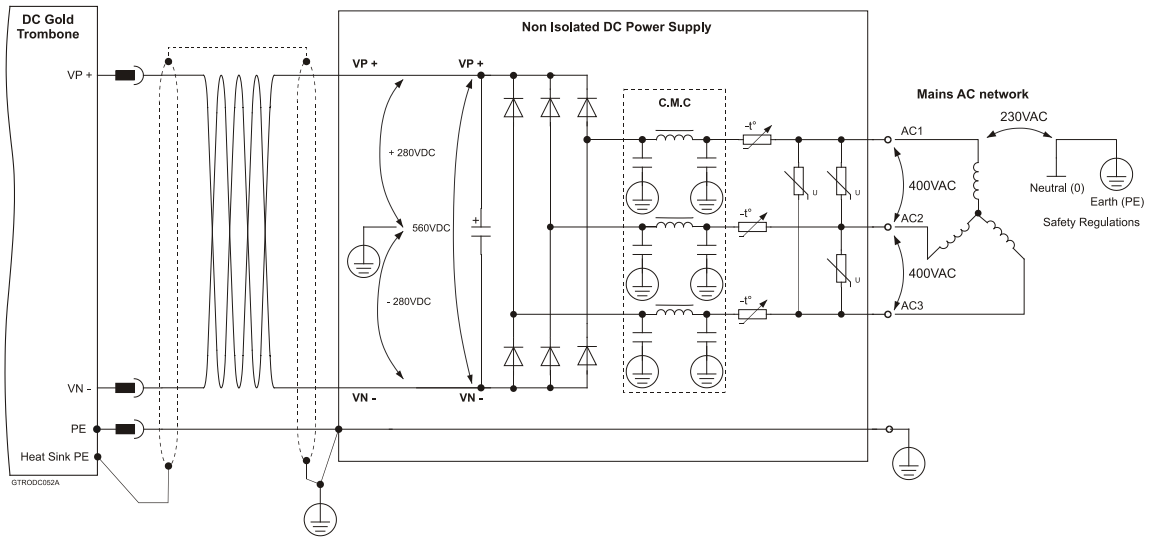


Figure 11: Non-Isolated Three-Phase Connection Topology

Caution:

- Do not connect VN- to PE. **In a direct-to-mains connection the VN- must *not* be connected to the PE,** as this will cause irreparable damage to the system.
- Take care and note that in a direct-to-mains connection the Neutral point is *not* the most negative voltage level. It is the mid-point level of the rectified DC bus.

4.7.2.1.b Single-Phase Direct-to-Mains Connection Topology

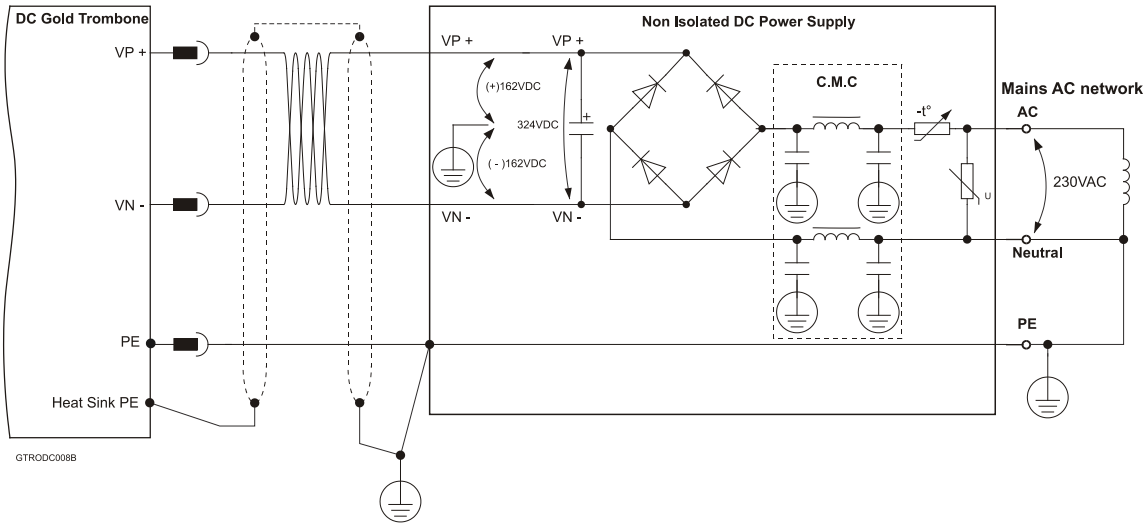


Figure 12: Non-Isolated Single-Phase Connection Topology

The Power Supply is connected directly to the mains AC line.

Warnings:

- Do not connect VN- to PE. **In a direct-to-mains connection the VN- must *not* be connected to the PE,** as this will cause irreparable damage to the system.
- Take care and note that in a direct-to-mains connection the Neutral point is *not* the most negative voltage level. It is the mid-point level of the rectified DC bus.

4.7.2.1.c Multiple Connections Topology

In a multi-axis application it is likely that a single power supply can feed several drives in parallel. The power supply is connected directly to the mains AC line and it feeds more than one drive.

This topology is efficient and cost saving, by reducing the number of power supplies and the amount of wiring. Most importantly it utilizes an energy sharing environment among all the drives that share the same DC bus network.

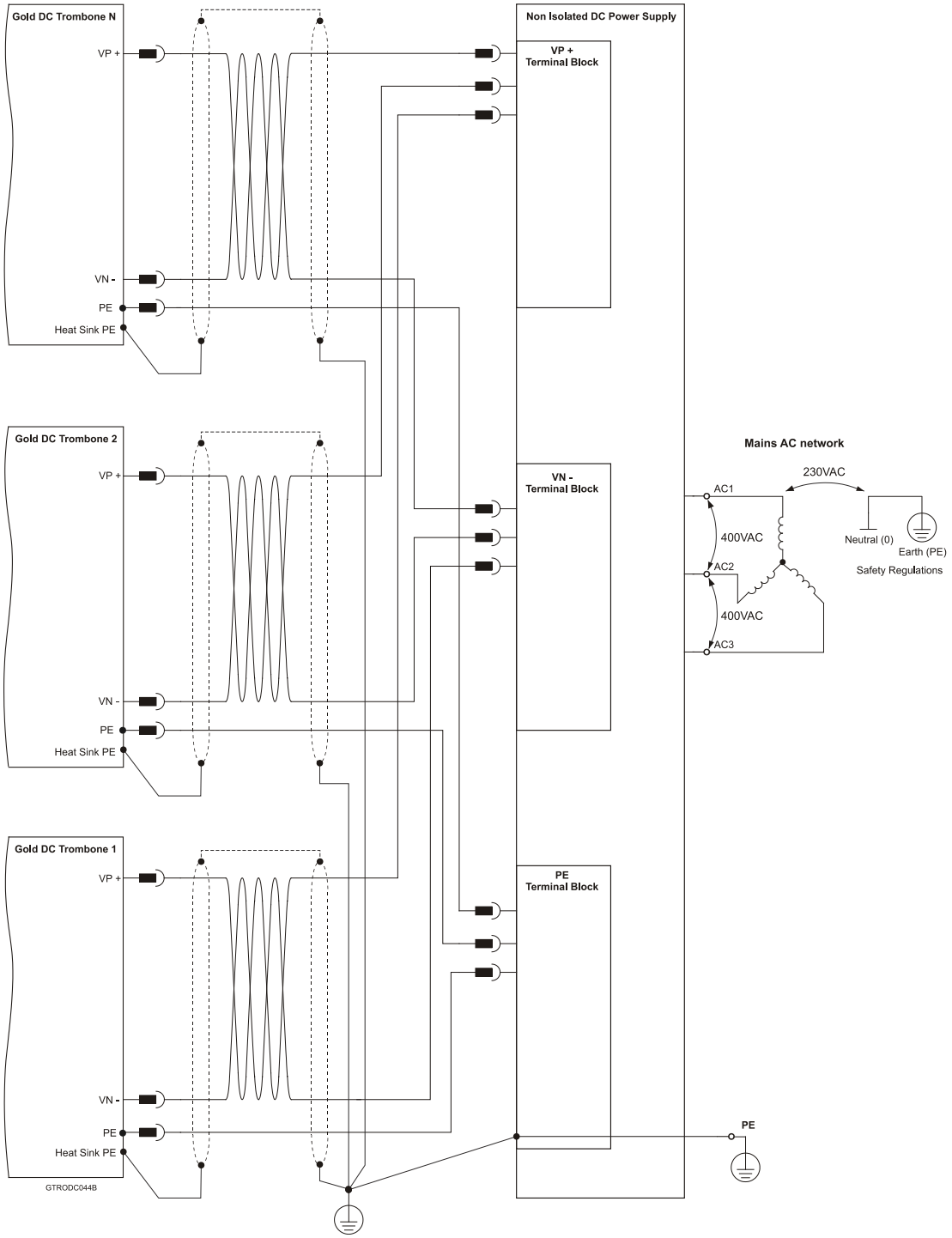


Figure 13: Non-Isolated Three-Phase Multiple Connection Topology

4.7.2.2. Battery Power Supply

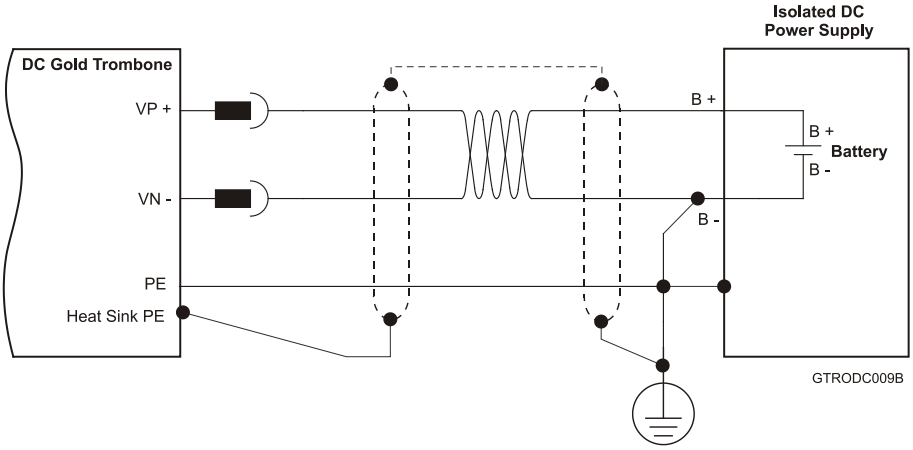


Figure 14: Battery Connection Topology

Caution: When using batteries, it is recommended to connect the negative pole to the PE.
When doing so, the charger of the battery **must** be isolated from the mains by an isolation transformer.

4.7.3. Control and Backup Supply

In drives that have a 0 or 1 suffix (only for 400 V model) in the catalog number, a smart control-supply algorithm enables the Gold DC Trombone to operate with the main power supply only, *with no need for an auxiliary supply voltage to supply the drive's logic section*.

Note that in such a model there is no backup ability at all.

If backup functionality is required to store control parameters in the event of a mains power outage, then an S, T, or AP-model Gold DC Trombone should be used, with an external 24 VDC isolated supply connected to it.

Note that the S, T, or AP-model Gold DC Trombone always requires an external 24 VDC power supply, regardless of whether or not backup functionality is required.

Connect the auxiliary 24 VDC power supply as described below.

To connect the 24 VDC backup supply:

1. Use a 24 AWG twisted pair shielded cable. The shield should have copper braid.
2. The source of the 24VDC backup supply must be isolated with an isolation transformer.
3. For safety and EMI reasons, connect the return of the 24VDC backup supply to the closest ground (PE).
4. Connect the cable shield to the closest ground (PE) near the power source.
5. Before applying power, first verify that the polarity of the connection is correct.

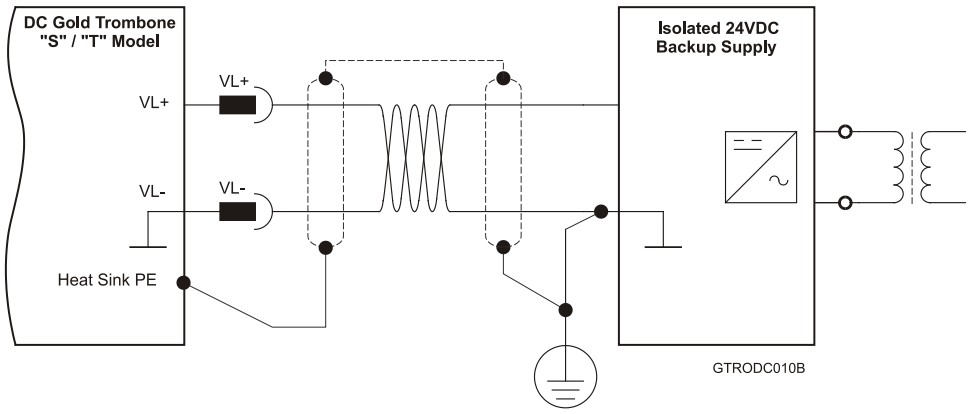


Figure 15: Auxiliary 24 VDC Backup Supply Connection Diagram

4.7.3.1. Optional Backup Supply

For S, T, or AP suffix drives.

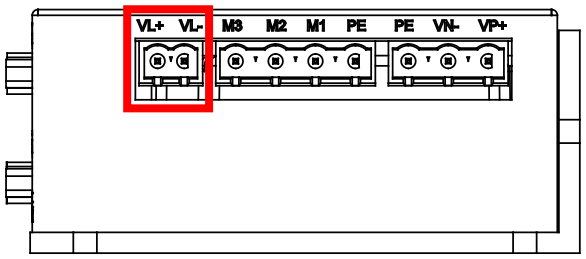
Pin	Function	Cable
In S, T, or AP suffix types:		
VL+	+24 V Auxiliary Supply Input Positive	DC Power
VL-	24 V RET Auxiliary Supply Input Return	DC Power
		

Table 16: Auxiliary 24 VDC Backup Supply Pins and Polarity

4.8. STO (Safe Torque Off) Inputs

Activation of Safe Torque Off causes the drive to stop providing power that can cause rotation (or motion in the case of a linear motor) to the motor.

This function may be used to prevent unexpected motor rotation (of brushless DC motors) without disconnecting the drive from the power supply.

The motor is active only as long as 24 VDC (or 5 V for the TTL option) is provided to both STO1 and STO2. Whenever any input voltage is no longer present, power is not provided to the motor and the motor shaft continues to rotate to an uncontrolled stop.

In circumstances where external influences (for example, falling of suspended loads) are present, additional measures such as mechanical brakes are necessary to prevent any hazard.

This function corresponds to an uncontrolled stop in accordance with Stop Category 0 of IEC 60204-1.

Note: This function does not protect against electrical shock, and additional measures to turn the power off are necessary.

The following table defines the behavior of the motor as a function of the state of the STO inputs:

Signal – STO1	Signal – STO2	Function
Not Active	Not Active	Motor is disabled
Not Active	Active	Motor is disabled
Active	Not Active	Motor is disabled
Active	Active	Motor can be enabled

Table 17: Motor Behavior according to Safety Inputs

Notes:

- In the Gold DC Trombone, STO1 also latches a software disable condition.
- The STO pins are located on the Port C connector – see Section 4.9.3.

Pin on Port C	Signal	Function
6	STO1	STO 1 input (default 24 V)
11	STO2	STO 2 input (default 24 V)
7, 12	STO_RET	STO signal return
Pin Positions		

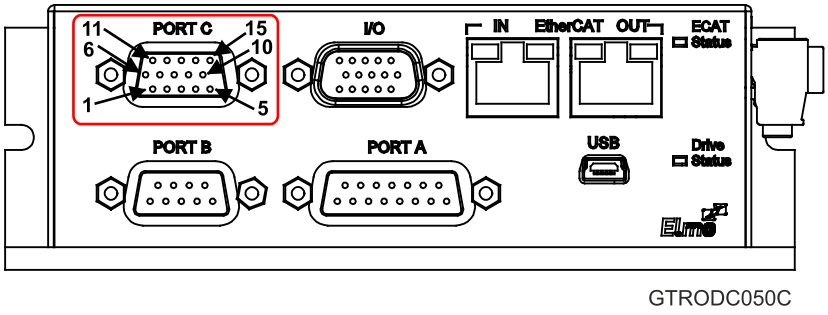


Table 18: STO Input Pin Assignments for S, T, 0, or 1 Suffix Models (non-AP Versions)

See the diagrams below for the PLC option connection and the TTL option connection.

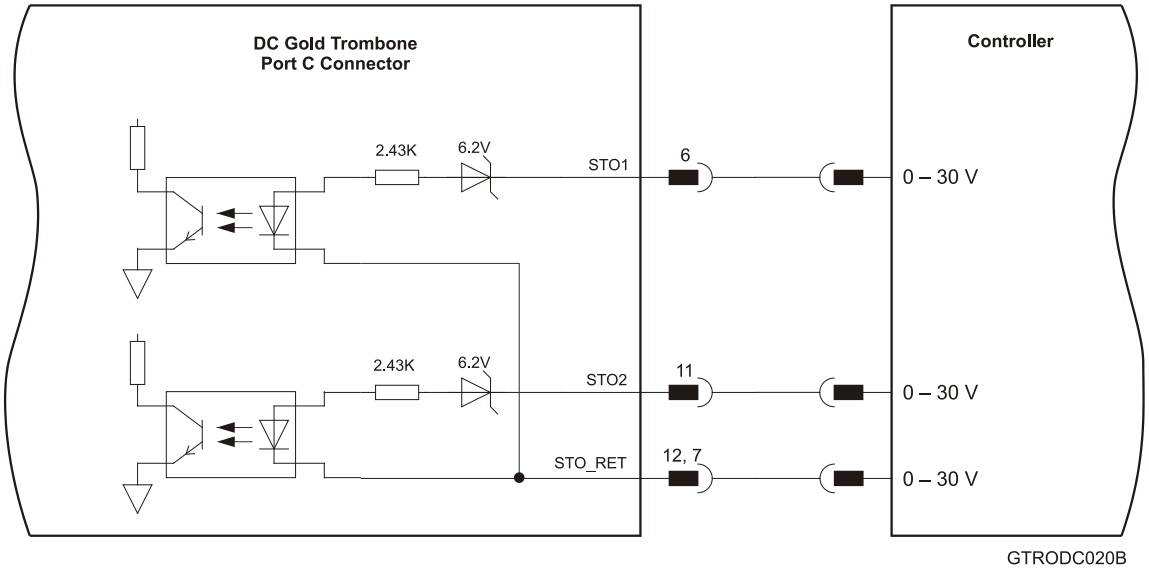


Figure 16: STO Input Connection – PLC Option for S or 0 Suffixes

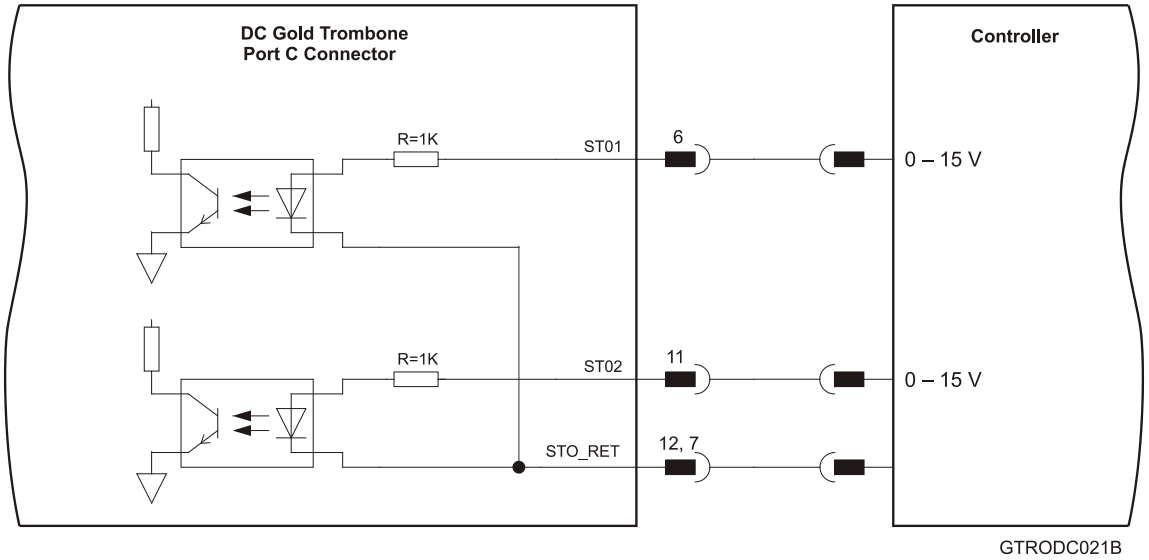


Figure 17: STO Input Connection – TTL Option for T or 1 Suffixes

Pin on Port C	Signal	Function
6	STO1	STO 1 input return
11	STO2	STO 2 input return
7, 12	STO_RET	STO input (default 24 V)
Pin Positions		

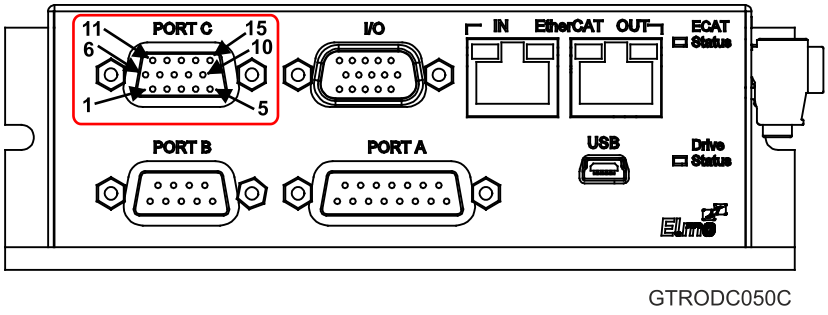


Table 19: STO Input Pin Assignments for the AP Version

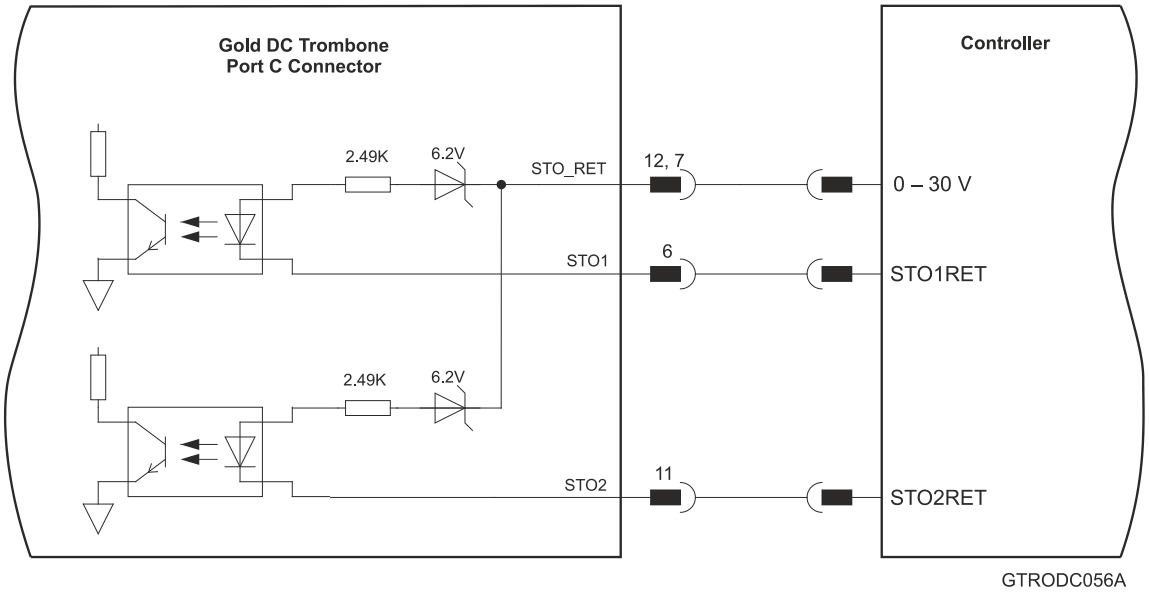


Figure 18: STO Input Connection – AP Option

4.9. Feedback

The Gold DC Trombone has two configurable motion sensor input ports; Port A and port B, and one emulated buffered output port; port C. Motion sensors from the controlled motor and from other sources can be connected to any of the available inputs on either port A or B. Software configuration designates each input a role, e.g., the incremental encoder on port B is the controlled motor position feedback, the Hall sensors on port A are commutation feedback, and the incremental encoder on port A is follower input.

For more information about sensors and their use refer to the Gold Line Software Manual.

The Gold DC Trombone features easy-to-use D-Sub type connections for all Control and Feedback cables. Instructions and diagrams describing how to assemble those cables are presented below.

1. Use 24, 26 or 28 AWG twisted-pair shielded cables (24 AWG cable is recommended). For best results, the shield should have aluminum foil covered by copper braid.
2. Use only a D-Sub connector with a **metal housing**.
3. Ideally, solder the drain wire to the connector body as shown in Figure 19.
   However, the shield may also be attached without soldering, as long as the braid shield is in tight contact with the metal housing of the D-type connector.
4. On the motor side connections, ground the shield to the motor chassis.
5. On controller side connections, follow the controller manufacturer's recommendations concerning the shield.

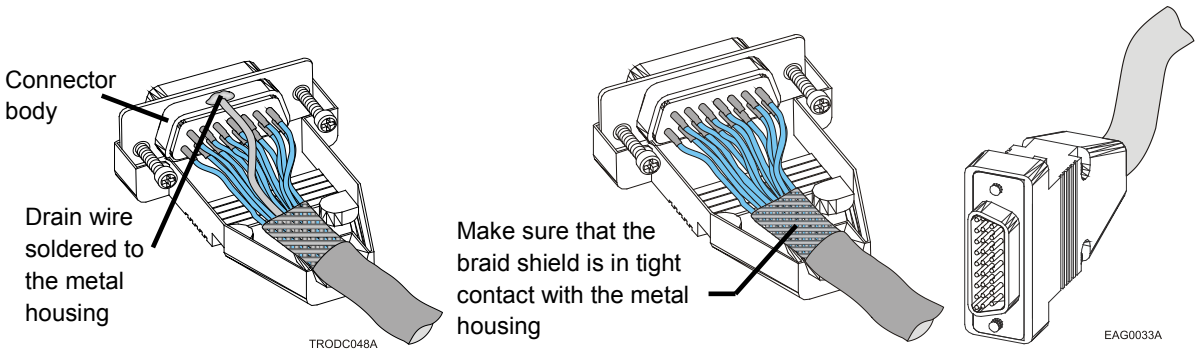


Figure 19: Feedback and Control Cable Assemblies

Note: All D-Sub type connectors, used with the Gold DC Trombone, should be assembled in this way.

4.9.1. Feedback Port A

Port A supports the following sensor inputs:

- Digital Hall sensors
- Incremental encoder or absolute serial encoder, depending on the specific model

Differential pulse-width modulation (PWM) signal input can be connected to port A in the models that support input from an incremental encoder. The PWM signal can be connected to the pair of matching + and – encoder channels and is configurable by software.

Differential Pulse & Direction signal inputs can be connected to port A in the models that support input from an incremental encoder. The signals can be connected to the pair of matching + and – encoder channels and are configurable by software.

	Incremental Encoder		Absolute Serial Encoder	
Pin on Port A	**Signal**	**Function**	**Signal**	**Function**
4,12	+5V	Encoder +5V supply	+5V	Encoder +5V supply
3,9,11, 13	SUPRET	Common return	SUPRET	Supply return
6	PortA_ENC_A+	Channel A+	ABS_CLK+	Abs encoder clock +
5	PortA_ENC_A-	Channel A-	ABS_CLK-	Abs encoder clock -
15	PortA_ENC_B+	Channel B+	ABS_DATA+	Abs encoder data +
14	PortA_ENC_B-	Channel B-	ABS_DATA-	Abs encoder data -
8	PortA_ENC_INDEX+	Index+	Reserved	Reserved
7	PortA_ENC_INDEX-	Index-	Reserved	Reserved
2	HA	Hall sensor A	HA	Hall sensor A
10	HB	Hall sensor B	HB	Hall sensor B
1	HC	Hall sensor C	HC	Hall sensor C
Pin Positions				

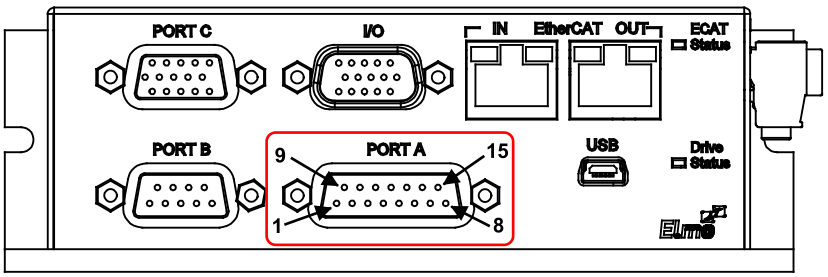


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Table 20: Port A Pin Assignments

4.9.1.1. Incremental Encoder

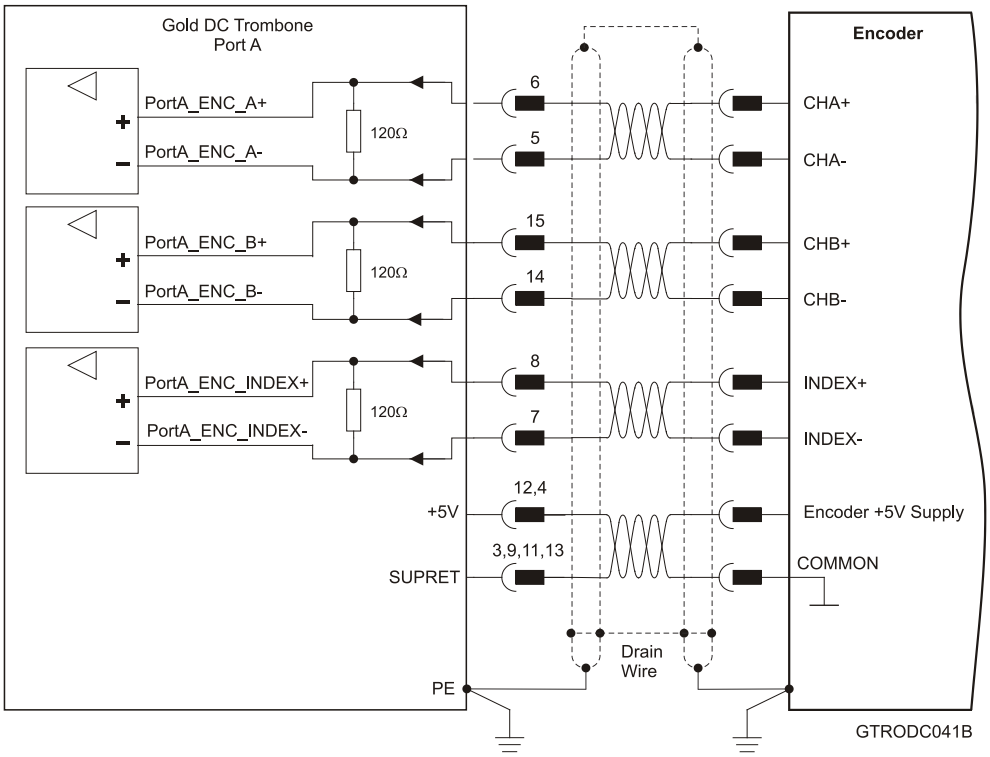


Figure 20: Port A Incremental Encoder Input – Recommended Connection Diagram

4.9.1.2. Absolute Serial Encoder

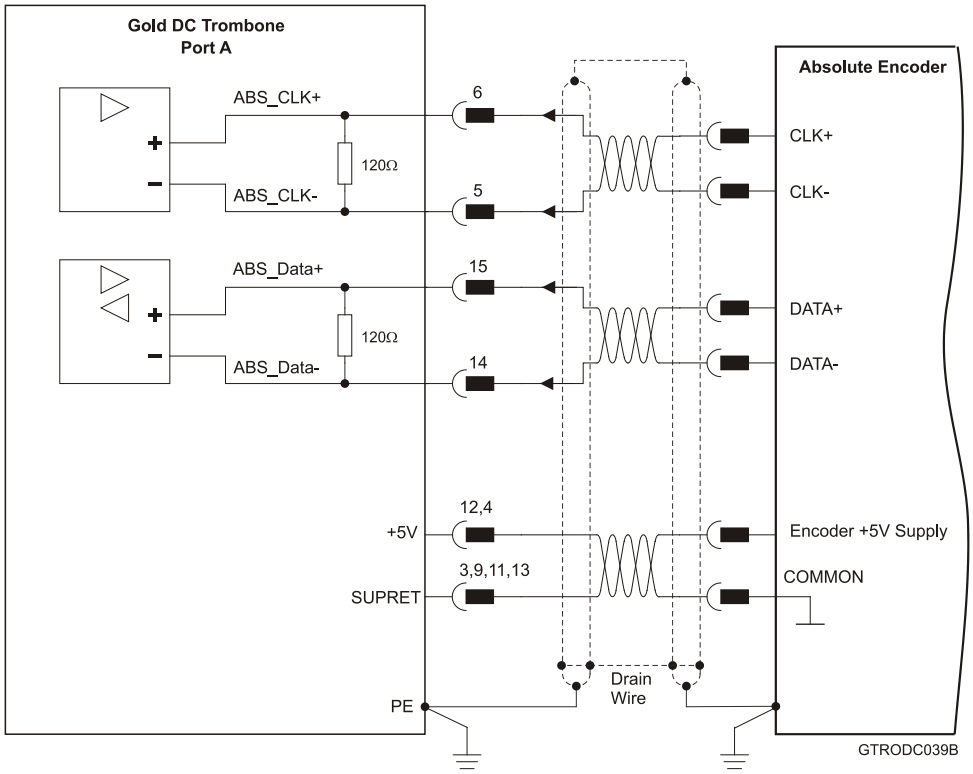


Figure 21: Absolute Serial Encoder – Recommended Connection Diagram for Sensors Supporting Data/Clock(e.g., Biss / SSI / EnDAT, etc.)

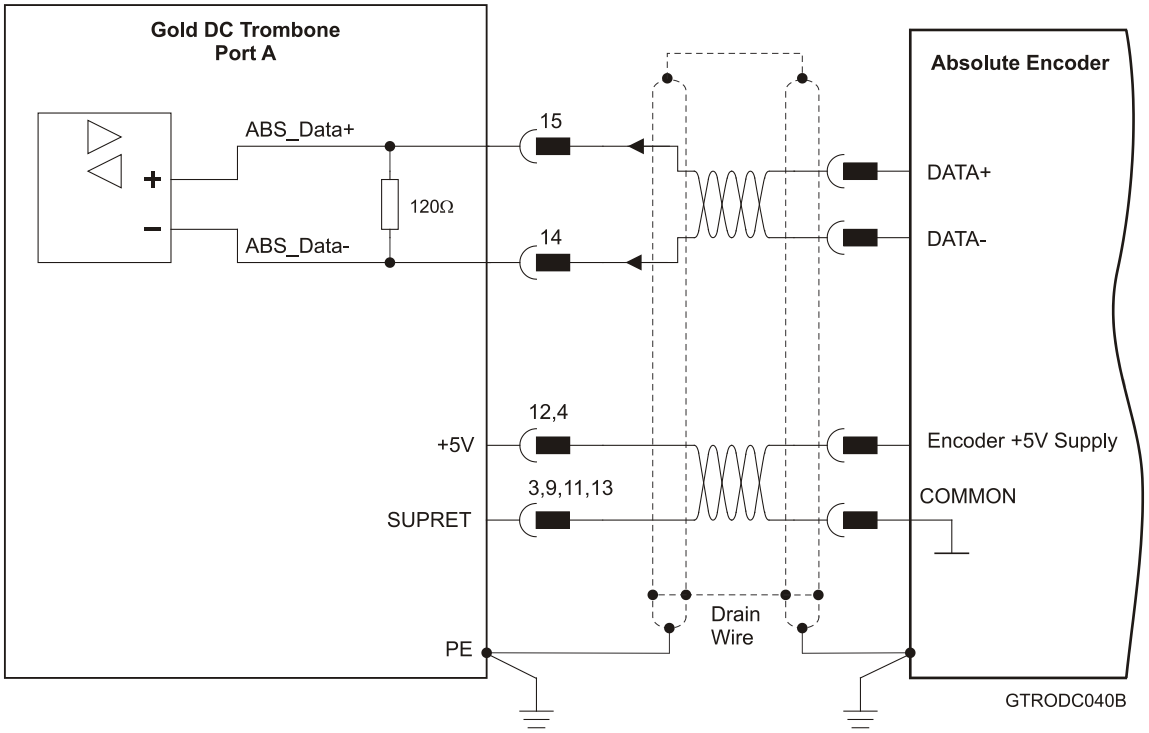


Figure 22: Absolute Serial Encoder – Recommended Connection Diagram for Sensors Supporting Data Line Only (NRZ types, e.g., Panasonic / Mitutoyo, etc.)

4.9.1.3. Hall Sensors

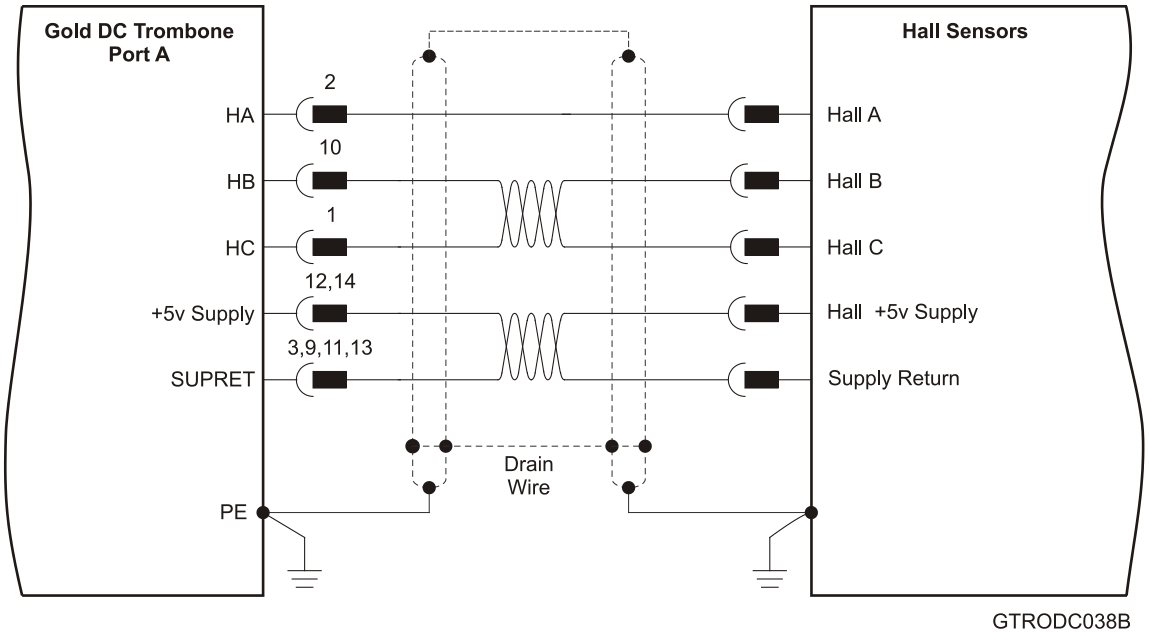


Figure 23: Hall Sensors Connection Diagram

4.9.2. Feedback Port B

Port B supports any of the following sensors:

- Incremental encoder, interpolated analog encoder or analog Hall sensors

Or:

- Resolver (separate hardware option)

Differential PWM signal input can be connected to port B in the models that support input from an incremental encoder. The PWM signal can be connected to the applicable pair of matching + and – encoder channels and is configurable by software.

Differential pulse and direction signal inputs can be connected to port B in the models that support input from an incremental encoder. The signals can be connected to the applicable pair of matching + and – encoder channels and are configurable by software.

	Incremental or Interpolated Analog Encoder		Resolver	
	G-DCTROXX/YYYXEX		G-DCTROXX/YYYXRX	
Pin on Port B	**Signal**	**Function**	**Signal**	**Function**
4	+5V	Encoder +5V supply	NC	
5, 9	SUPRET	Supply return	SUPRET	Supply return
1	PortB_ENC_A+/ SIN+	Incremental Encoder A+ / Sine+	SIN+	Sine+
6	PortB_ENC_A-/ SIN-	Channel A- / Sine-	SIN-	Sine-
2	PortB_ENC_B+/Cos+	Channel B+ / Cosine+	COS+	Cosine+
7	PortB_ENC_B-/Cos-	Channel B - / Cosine -	COS-	Cosine-
3	PortB_ENC_INDEX+	Index +	RESOLVER_OUT+	Vref f=1/TS, 50 mA Max.
8	PortB_ENC_INDEX-	Index -	RESOLVER_OUT-	Vref complement f= 1/TS, 50 mA Maximum
Pin Positions				

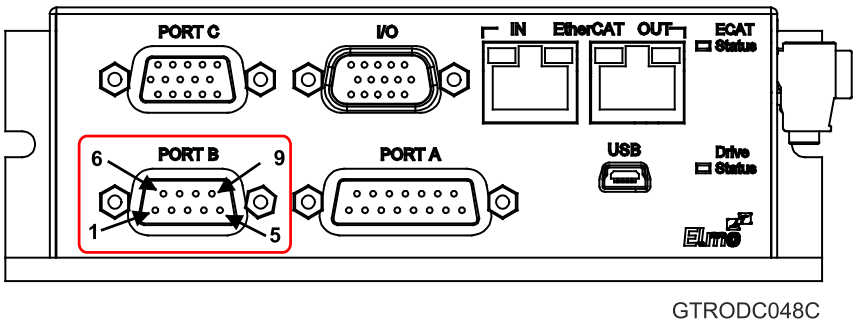


Table 21: Port B Pin Assignments

4.9.2.1. Incremental Encoder

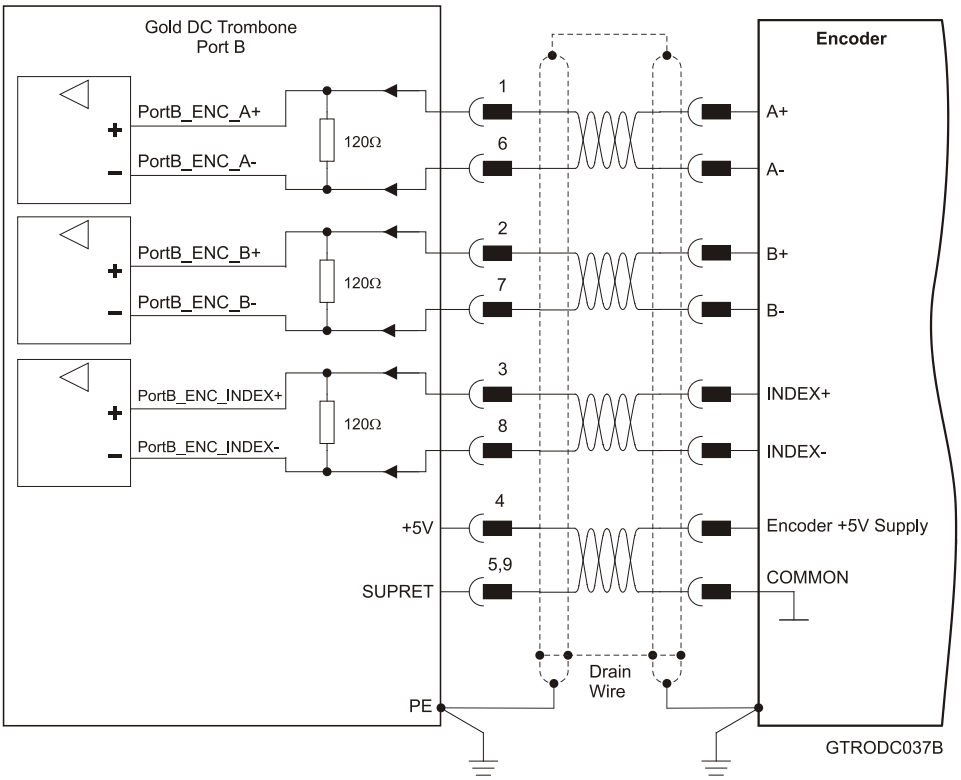


Figure 24: Port B Incremental Encoder Input – Recommended Connection Diagram

4.9.2.2. Interpolated Analog Encoder

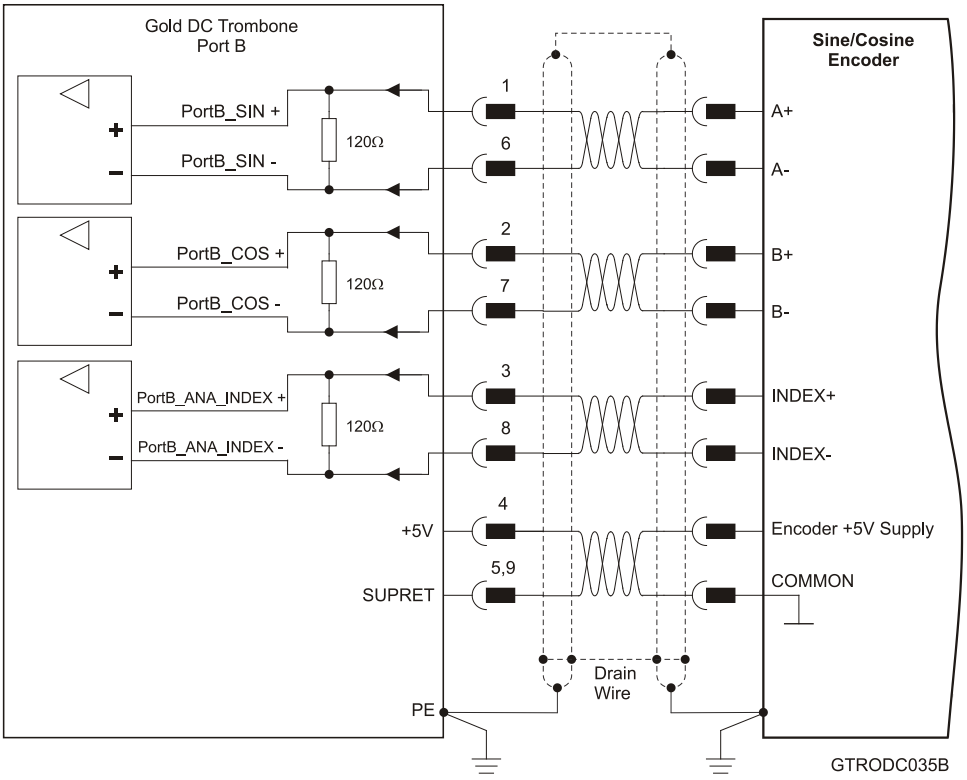


Figure 25: Port B - Interpolated Analog Encoder Connection Diagram

4.9.2.3. Resolver

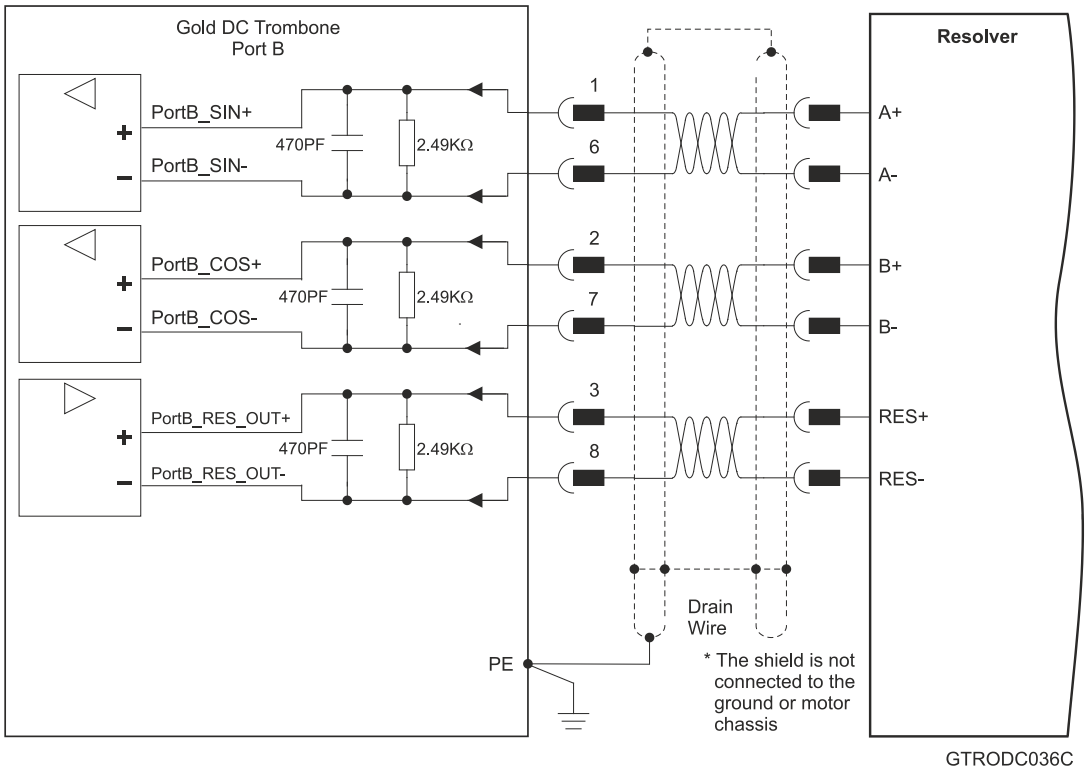


Figure 26: Port B – Resolver Connection Diagram

4.9.3. Port C – Emulated Encoder Output

Port C provides emulated encoder output derived from port A or port B feedback inputs, or from internal variables. The output options are:

- Port A/B daisy chain (1:1) for incremental encoder
- Encoder emulation: Emulate any input sensor, digital or analog, or use to emulate an internal variable such as virtual profiler.
- PWM output: Any pair of outputs that is used as an encoder channel (e.g. channel A+ and channel A-) can be configured by software to become PWM output.
- Pulse & Direction output: The output pins that are assigned as channel A and channel B when used as encoder out can be configured by software to become pulse and direction outputs respectively.

This port is used when:

- The Gold DC Trombone is used as a current amplifier to provide position data to the position controller.
- The Gold DC Trombone is used in velocity mode, to provide position data to the position controller.
- The Gold DC Trombone is used as a master in follower or ECAM mode.

Pin on Port C	Signal	Function
1	PortC_ENCO_A+	Buffered Channel A+ output / Pulse+ / PWM+
2	PortC_ENCO _A-	Buffered Channel A- output / Pulse- / PWM-
3	PortC_ENCO _B+	Buffered Channel B+ output / Dir+
4	PortC_ENCO _B-	Buffered Channel B- output / Dir-
5	PortC_ENCO _ Index+	Buffered Channel INDEX+ output
10	PortC_ENCO _ Index-	Buffered Channel INDEX- output
9	COMRET	Common return
Pin Positions		

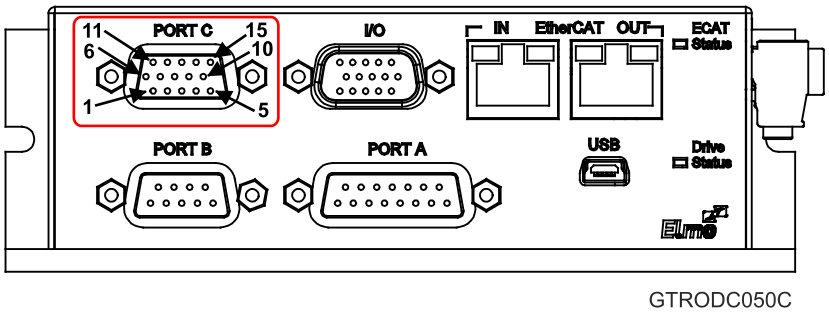


Table 22: Port C Pin Assignments

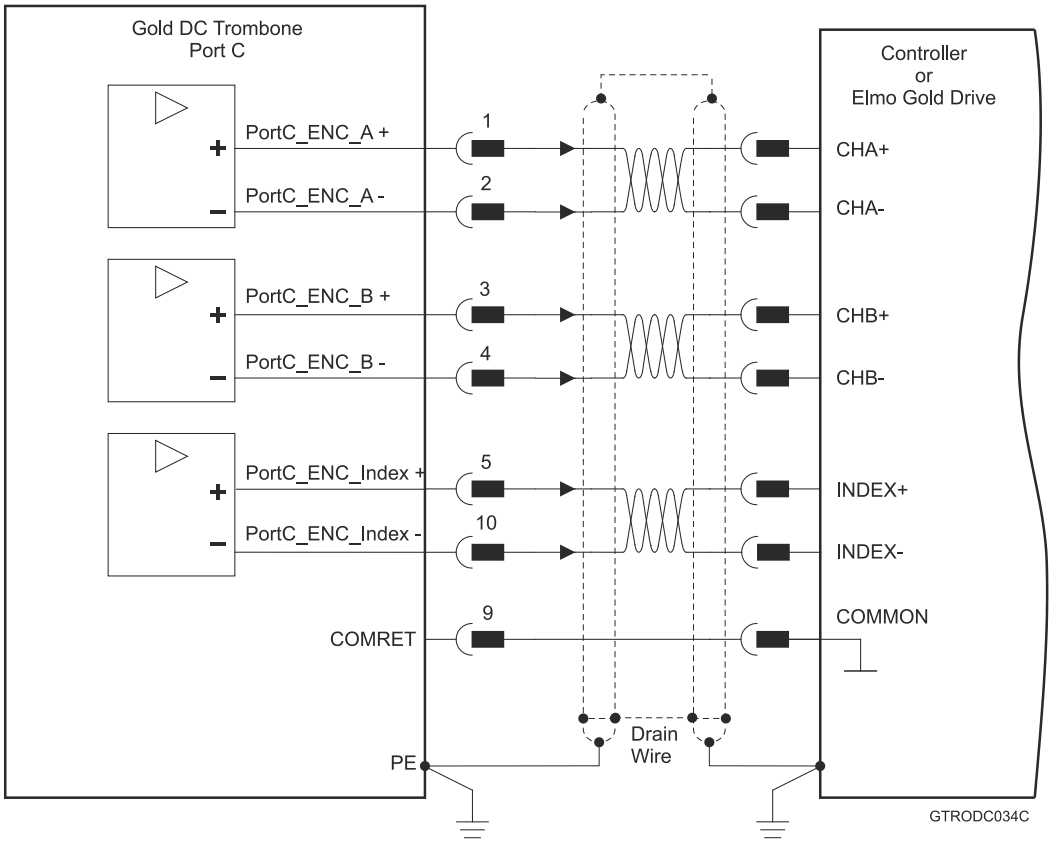


Figure 27: Emulated Encoder Differential Output – Recommended Connection Diagram

4.10. User I/Os

The Gold DC Trombone has six programmable digital inputs, four digital outputs and one analog input.

I/O	I/O Connector	Port C & STO & Analog
Digital Input	6	-
Digital Output	4	-
Analog Input	-	1

4.10.1. I/O Connector Pinout

Each of the pins below can function as an independent input.

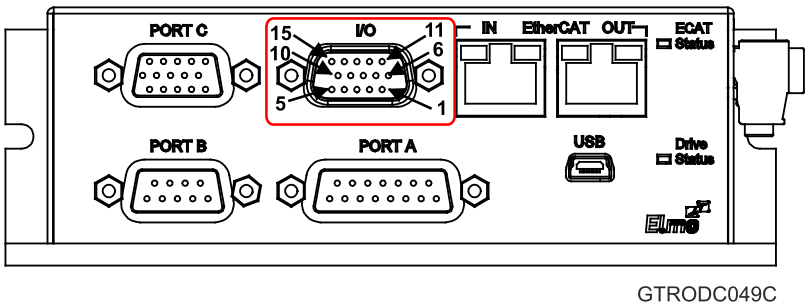
Pin on I/O	Signal	Function
1	IN1	High speed programmable input 1 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
2	IN2	High speed programmable input 2 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
7	IN3	High speed programmable input 3 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
8	IN4	High speed programmable input 4 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
11	IN5	High speed programmable input 5 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
12	IN6	High speed programmable input 6 (event capture, home, general purpose, RLS, FLS, INH, PWM & dir input, pulse & dir input)
6	INRET1-6	Programmable inputs 1 - 6 return for standard version Programmable positive inputs 1 - 6 for AP version
3	OUT1	Programmable digital output 1
4	OUT2	Programmable digital output 2
5	OUT3	Programmable digital output 3
13	OUT4	Programmable digital output 4
10, 15	VDD	Supply for out 1-4
9, 14	VDDRET	Supply return for out 1-4
Pin Positions		
 GTRODC049C		

Table 23: Digital Input and Output Pin Assignments

4.10.1.1. Digital Input

Each of the pins below can function as an independent input.

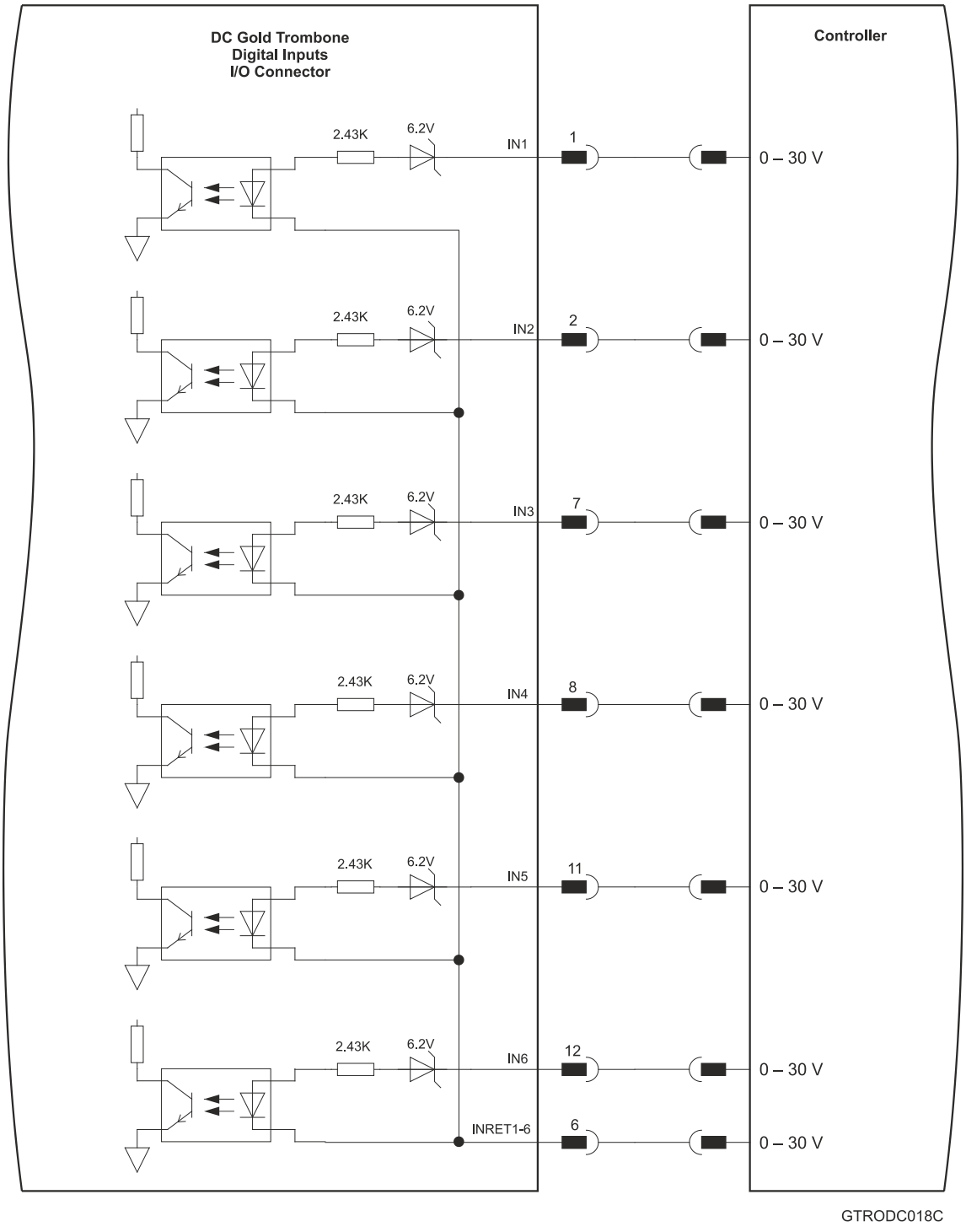


Figure 28: Digital Input PLC Mode Connection Diagram – for S or 0 Suffixes

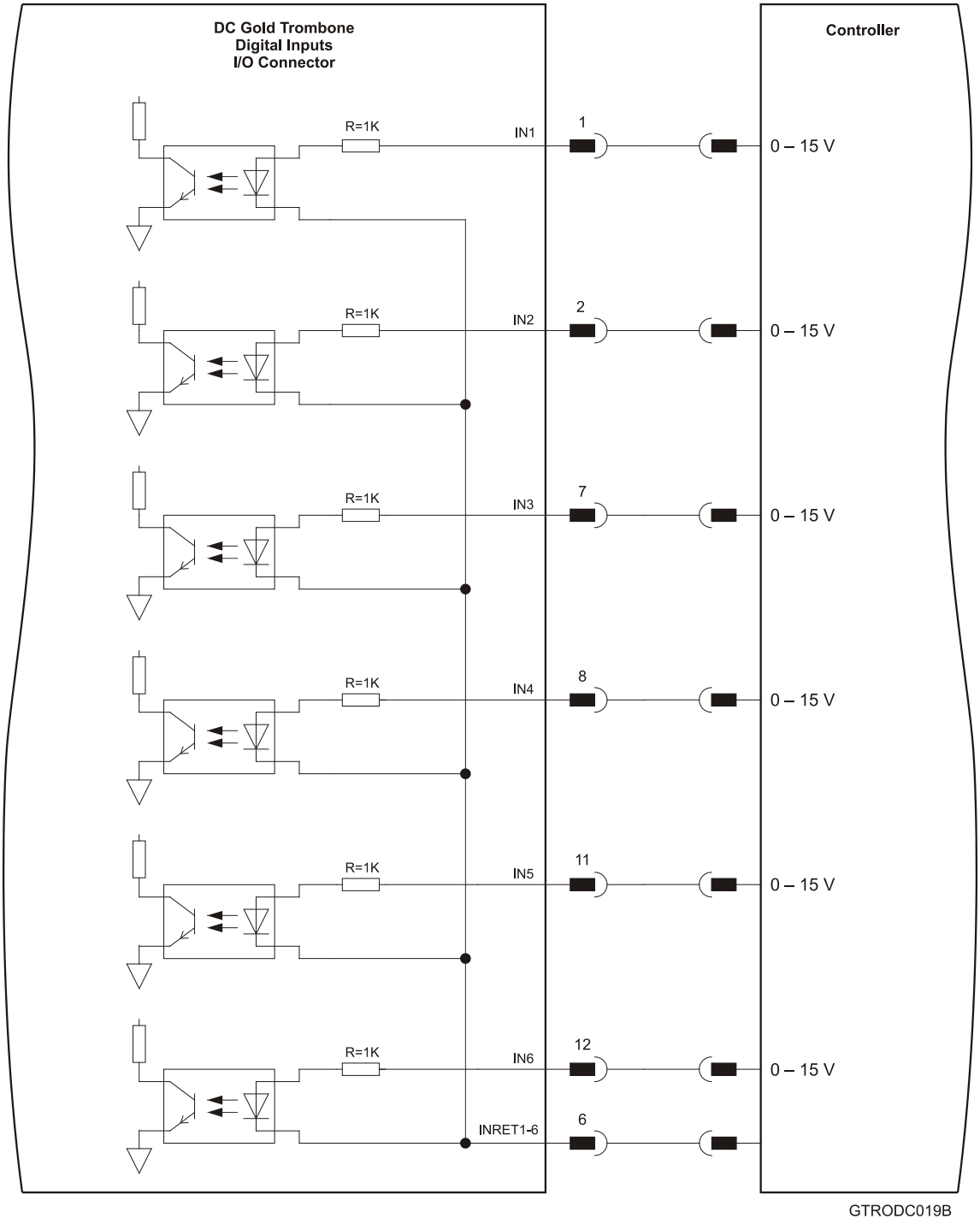


Figure 29: Digital Input TTL Mode Connection Diagram – for T or 1 Suffixes

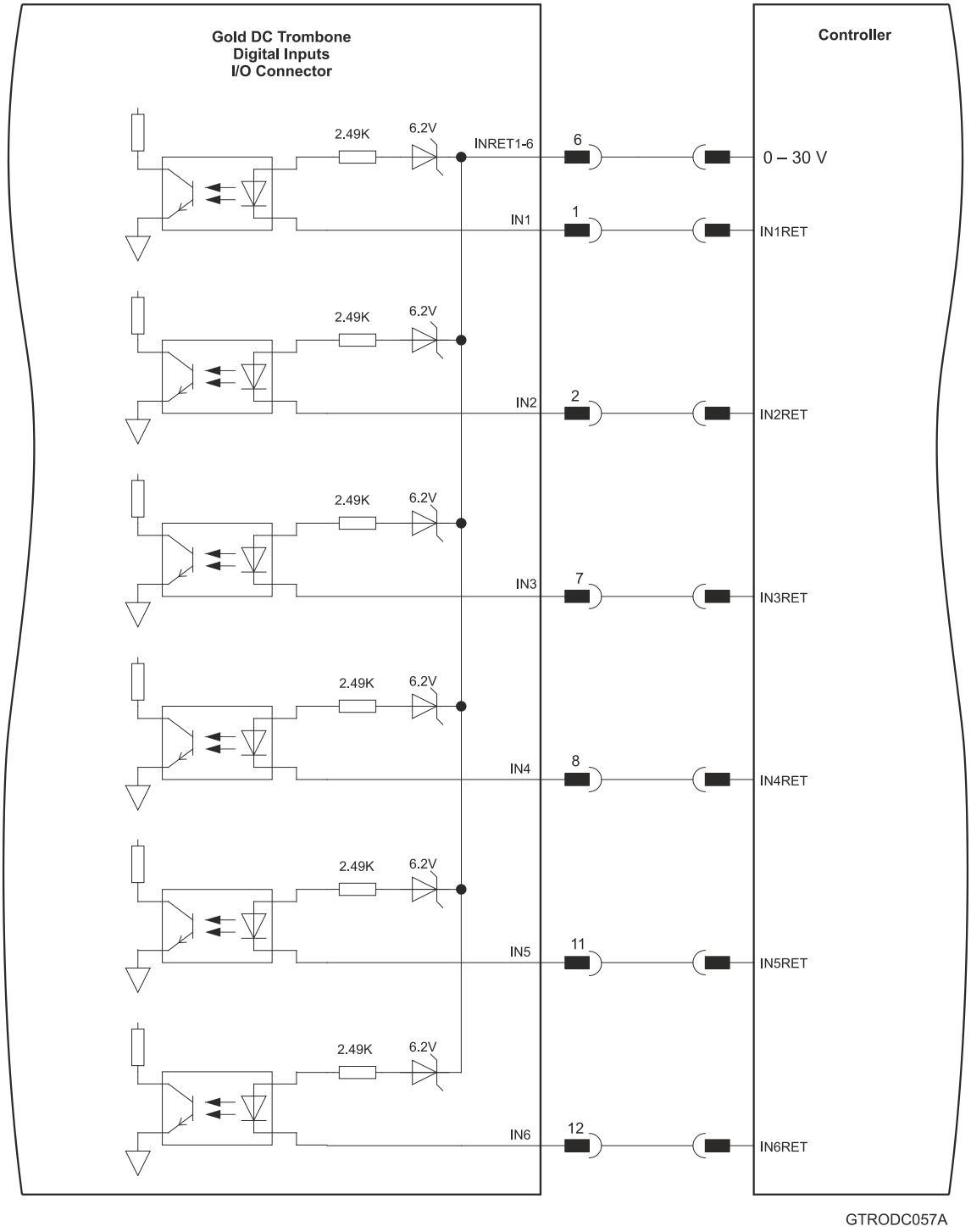


Figure 30: Digital Input AP Mode Connection Diagram

4.10.1.2. Digital Output

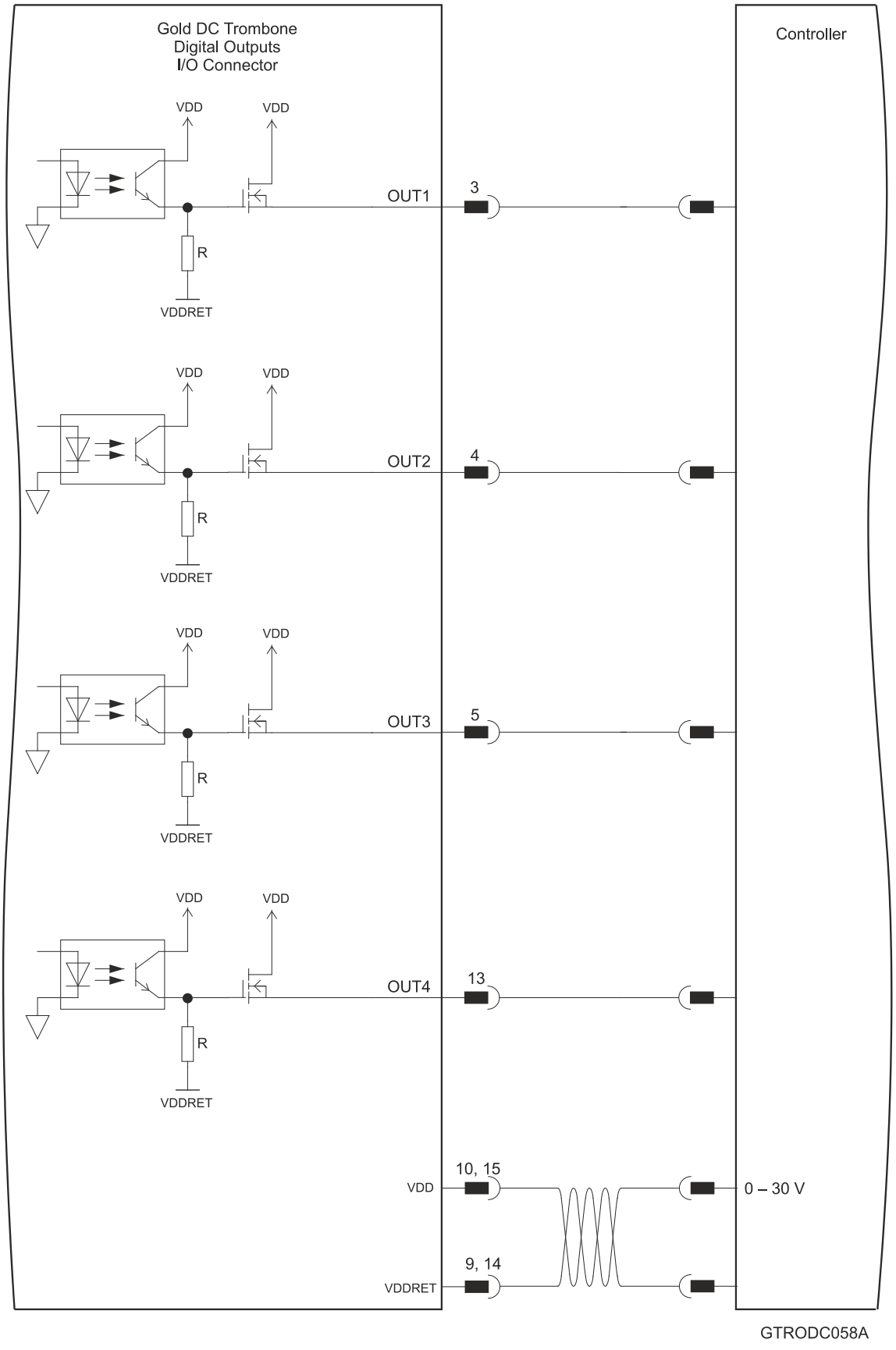


Figure 31: Digital Output Connection Diagram – PLC option, for S or 0 Suffixes

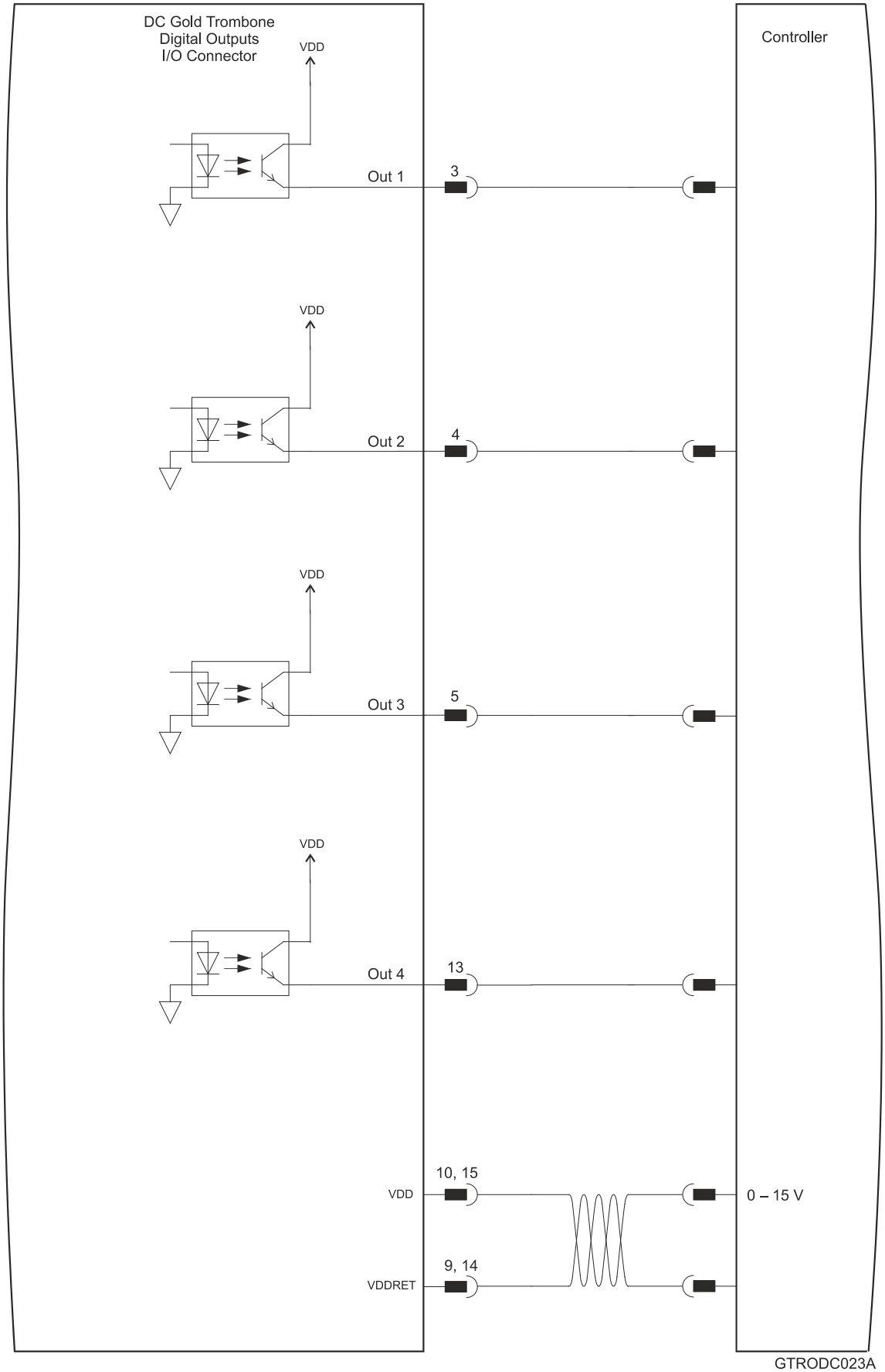


Figure 32: Digital Output Connection Diagram – TTL Option, for T or 1 Suffixes

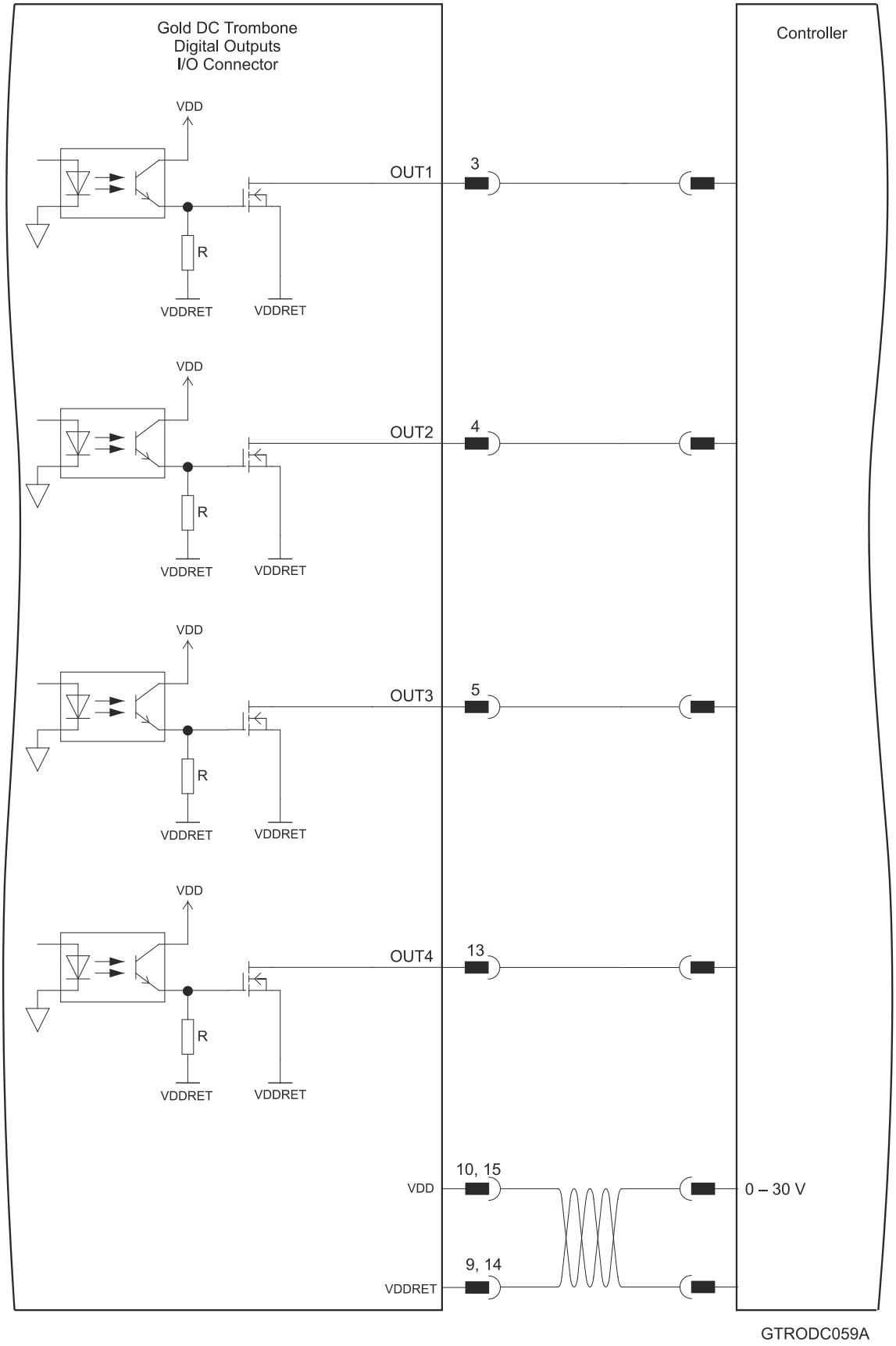
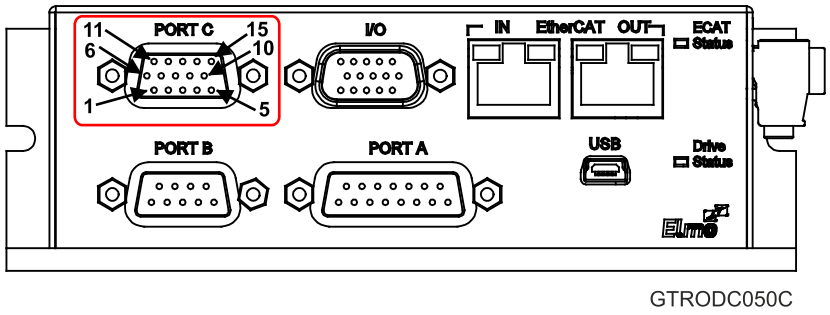


Figure 33: Digital Output Connection Diagram – AP Option

4.10.2. Analog Input

Note: The Analog Input pins are located on the Port C connector – see Section 4.9.3.

Pin on Port C	Signal	Function
15	ANALOG1+	Analog input 1+
14	ANALOG1-	Analog input 1-
13	ANLRET	Analog ground
Pin Positions		



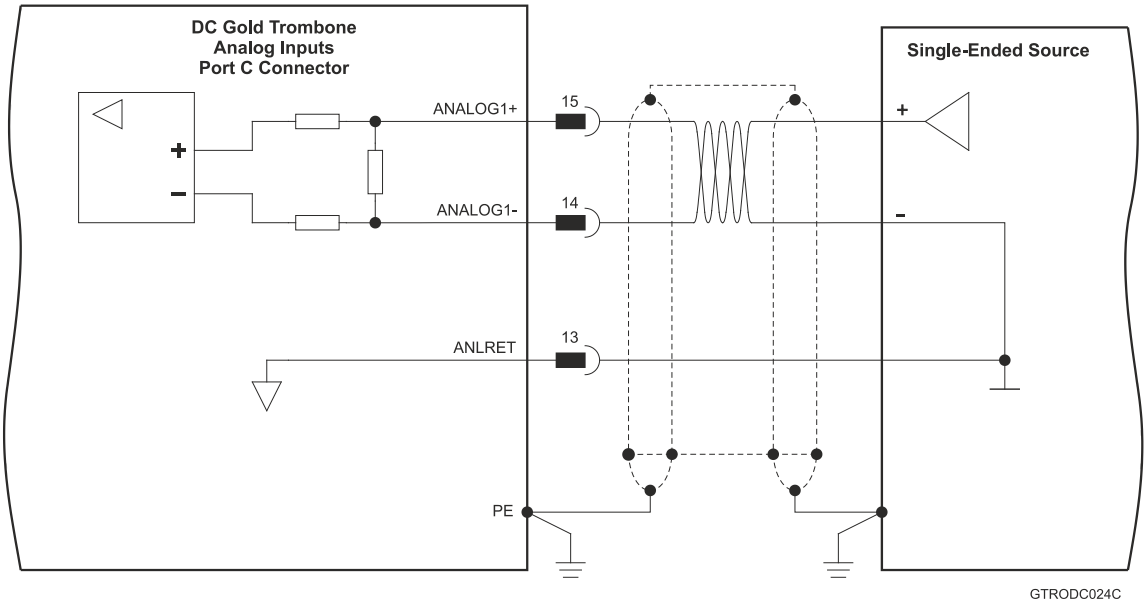


Figure 34: Analog Input with Single-Ended Source

4.11. Communications

The communication interface may differ according to the user's hardware. The Gold DC Trombone can communicate using the following options:

Standard	EtherCAT
G-DCTROXX/YYY**S**XX	**G-DCTRO**XX/YYY**E**XX
CANopen	EtherCAT or Ethernet
USB 2.0	USB 2.0

Table 24: Gold DC Trombone Communication Options

NOTE: **When the EtherCAT is connected, and FoE in operation, the USB cable connection must be disconnected.**

4.11.1. USB 2.0 Communication

The USB network consists of Host controller and multiple devices. The Gold DC Trombone is a USB Device.

To connect the USB communication cable:

1. Connect a mini USB cable.
2. D+ and D- comprise a twisted pair in the cable.
3. The maximum cable length is 5 m.
4. The cable shield should only be connected to ground at the host.
5. The shield of the cable is connected to the shield of the connector used for communication.

Pin on USB	Signal	Function
1	USB VBUS	USB VBUS 5V
2	USBD-	USB _N line
3	USBD+	USB _P line
5	USB COMRET	USB communication return
Pin Positions		

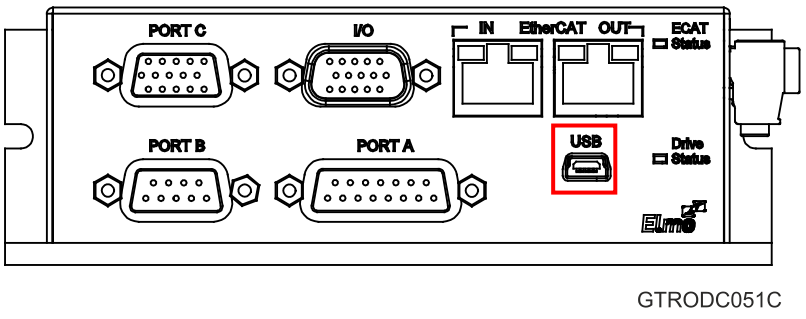


Table 25: USB 2.0 - Pin Assignments

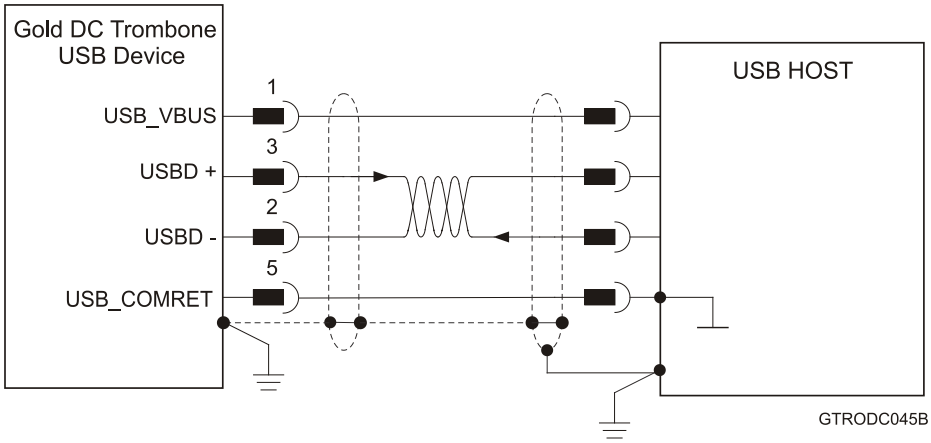


Figure 35: USB Network Diagram

4.11.2. EtherCAT Communication Version

4.11.2.1. EtherCAT Communication

Notes:

- The EtherCAT IN port can be configured as an Ethernet port for TCP/IP – see the EtherCAT Manual.
- It is recommended to use CAT5e (or higher) cable. Category 5e cable is a high signal integrity cable with four twisted pairs.

Pin	Signal	Function
1	Ethernet_TX+	Ethernet transmit +
2	Ethernet_TX-	Ethernet transmit -
3	Ethernet_RX+	Ethernet receive +
4/5	N/A	
6	Ethernet_RX-	Ethernet receive -
7/8	N/A	
Pin Positions		

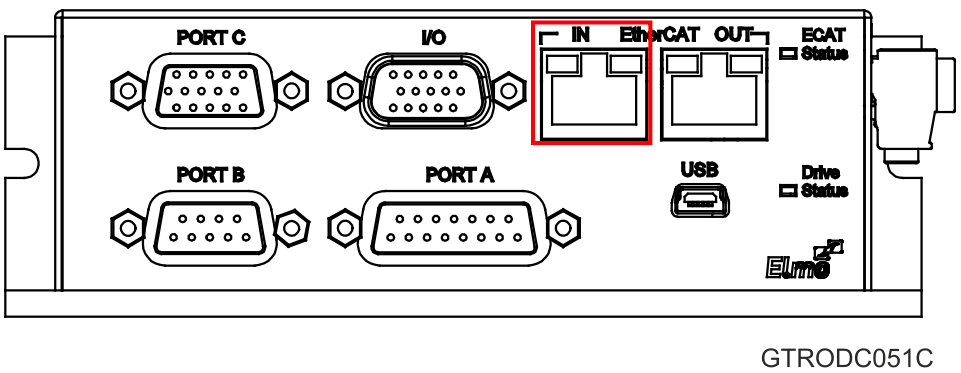


Table 26: EtherCAT In Connector

Pin	Signal	Function
1	EtherCAT_OUT_TX+	EtherCAT out transmit +
2	EtherCAT_OUT_TX-	EtherCAT out transmit -
3	EtherCAT_OUT_RX+	EtherCAT out receive +
4/5	N/A	
6	EtherCAT_OUT_RX-	EtherCAT out receive -
7/8	N/A	
Pin Positions		

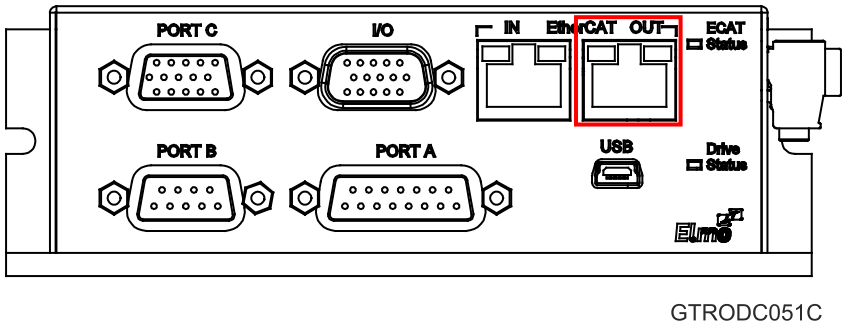


Table 27: EtherCAT Out Connector

When connecting several EtherCAT devices in a network, the EtherCAT master must always be the first device in the network. The output of each device is connected to the input of the next device. The output of the last device may remain disconnected. If redundancy is required, the output of the last device should be connected to the input of the EtherCAT master.

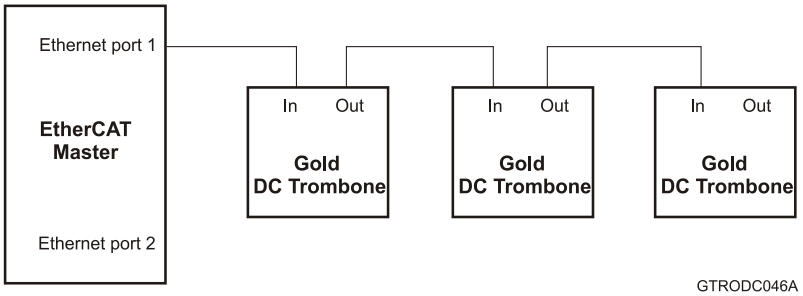


Figure 36: EtherCAT Network with No Redundancy

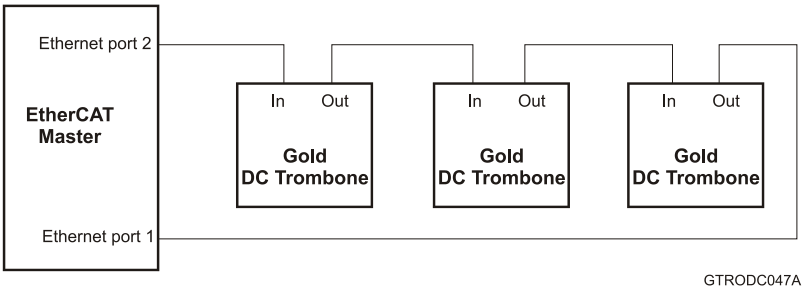


Figure 37: EtherCAT Network with Redundancy

4.11.2.2. Ethernet Communication

To connect the Ethernet communication cable:

1. The EtherCAT IN port can be configured as an Ethernet port for TCP/IP – see the EtherCAT Manual.
2. It is recommended to use CAT5e (or higher) cable. Category 5e cable is a high signal integrity cable with four twisted pairs.

Pin	Signal	Function
1	Ethernet_TX+	Ethernet transmit +
2	Ethernet_TX-	Ethernet transmit -
3	Ethernet_RX+	Ethernet receive +
4/5	N/A	
6	Ethernet_RX-	Ethernet receive -
7/8	N/A	
Pin Positions		

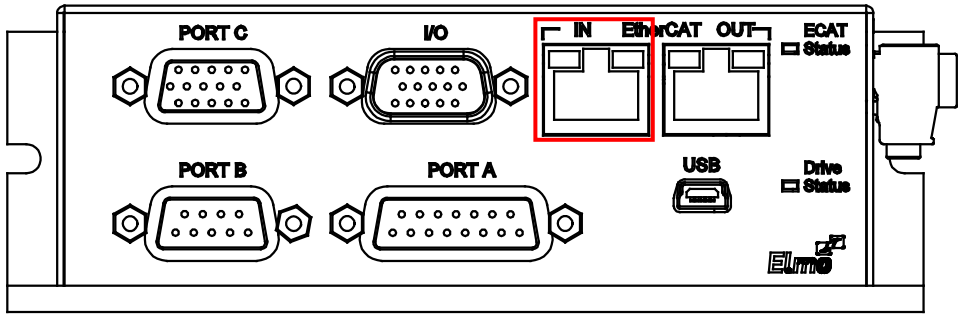


Table 28: Ethernet - EtherCAT In Connector Pin Assignments

4.11.3. CANopen Communication Version

Notes for connecting the CANopen communication cable:

- Use 26 or 28 AWG twisted pair shielded cables. For best results, the shield should have aluminum foil and covered by copper braid with a drain wire
- Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.
- The male RJ plug must have a shield cover.
- Ensure that the shield of the cable is connected to the shield of the RJ plug. The drain wire can be used to facilitate the connection.
- Connect a termination 120-Ohms resistor at each of the two ends of the network cable.

Pin	Signal	Function
1	CAN_H	CAN_H bus line (dominant high)
2	CAN_L	CAN_L bus line (dominant low)
3	CAN_RET	CAN Return
4, 5	N/A	—
6	CAN_SHLD	Shield, connected to the RJ plug cover
7	CAN_RET	CAN Return
8	N/A	—

Pin Positions

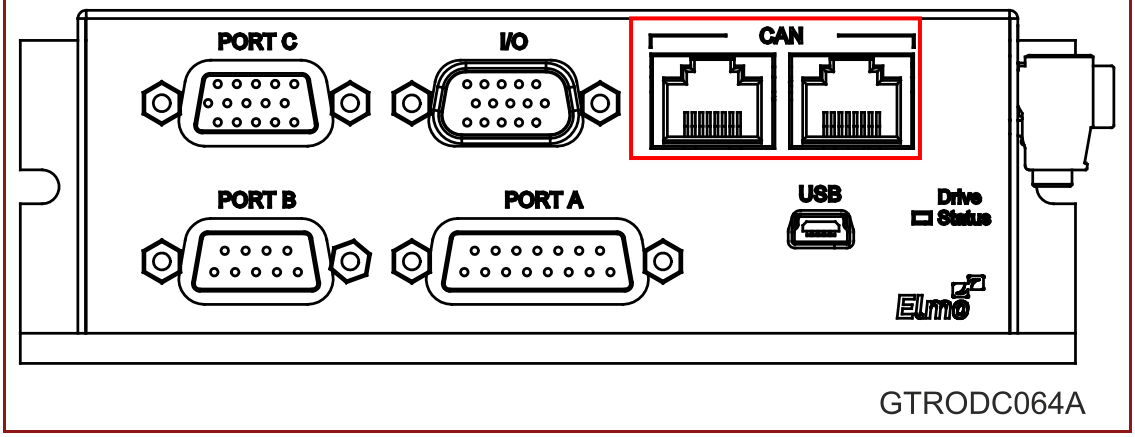
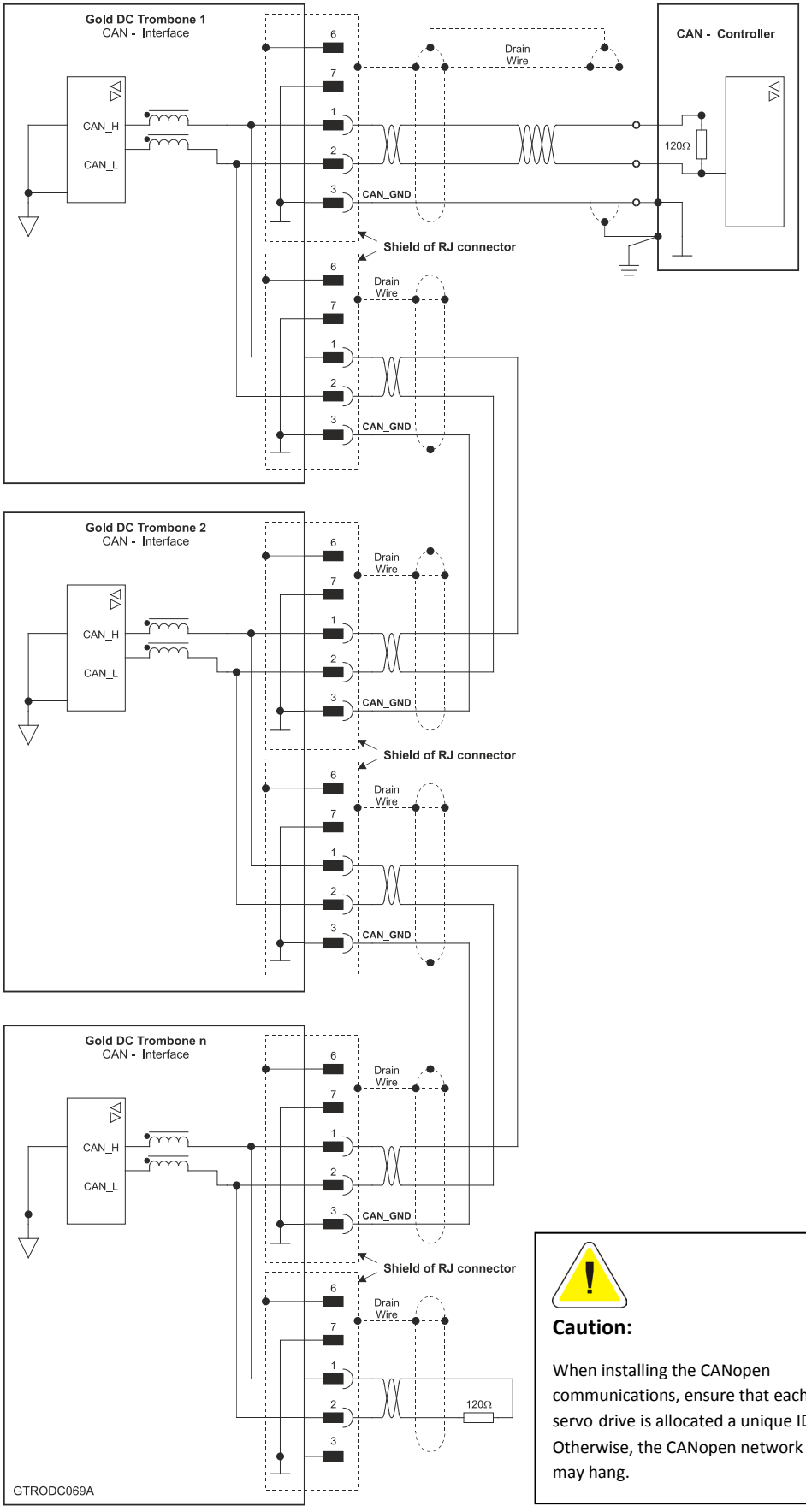


Table 29: CANopen Connectors - Pin Assignments



Caution:

When installing the CANopen communications, ensure that each servo drive is allocated a unique ID. Otherwise, the CANopen network may hang.

Figure 38: CANopen - Connection Diagram

4.12. Powering Up

After the Gold DC Trombone is connected to its peripheral devices, it is ready to be powered up.

Caution: Before applying power, ensure that:

1. The DC supply is within the specified range.
2. The proper plus-minus connections are in order.
3. The VN- is not connected to the PE or to the Neutral, when working with a non-isolated power supply**.**

4.12.1. Initializing the System

After the Gold DC Trombone has been connected and mounted, the system must be set up and initialized. This is accomplished using the Elmo Application Studio, Elmo's Windows-based software application. Install the application and then perform setup and initialization according to the directions in the Elmo Application Studio User's Manual.

Chapter 5: Technical Specifications

This chapter provides detailed technical information regarding the Gold DC Trombone. This includes its dimensions, power ratings, the environmental conditions under which it can be used, the standards to which it complies and other specifications.

5.1. Features

The Gold DC Trombone's features determine how it controls motion, as well as how it processes host commands, feedback and other input.

5.1.1. Motion Control Modes

- Current/Torque - up to 20 kHz sampling rate (50 µs)
- Velocity - up to 10 kHz sampling rate (100 µs)
- Position - up to 10 kHz sampling rate (100 µs)

5.1.2. Advanced Positioning Control Modes

- PTP, PT, PVT, ECAM, Follower, Dual Loop, Current Follower, Fast event capturing inputs
- Fast output compare (OC)
- Motion Commands: Analog current and velocity, pulse-width modulation (PWM) current and velocity, digital (SW) and Pulse and Direction

5.1.3. Advanced Filters and Gain Scheduling

- “On-the-Fly” gain scheduling of current and velocity
- Velocity and position with “1-2-2” PIP controllers
- Automatic commutation alignment
- Automatic motor phase sequencing
- Current gain scheduling to compensate for the motor's non-linear characteristics
- Advanced filtering: Low pass, Notch, General Biquad
- Current loop gain scheduling to compensate for bus voltage variations
- Velocity gain scheduling for reliable velocity loop performance
- Gains & filter scheduling vs. position for mechanical coupling optimization, speed and position tracking errors
- High order filters gain scheduling vs. speed and position

5.1.4. Fully Programmable

- Third generation programming structure
- Event capturing interrupts
- Event triggered programming

5.1.5. Feedback Options

- Incremental Encoder – up to 75 Megacounts per second (18 MHz PPS (Pulses Per Second))
- Digital Halls:
  - Up to 4 kHz commutation frequency
  - 5 V logic
  - Input voltage up to 15 VDC
- Incremental encoder with digital Halls for commutation – up to 75 Megacounts per second for encoder
- Interpolated Analog (Sine/Cosine) Encoder:
  - Supports 1 V PTP Sin/Cos
  - Sin/Cos frequency: up to 500 kHz
  - Internal interpolation: up to ×8192
  - Automatic correction of amplitude mismatch, phase mismatch, signal offset
  - Emulated encoder output of the analog encoder
- Analog Hall Sensor:
  - One feedback electrical cycle = one electrical cycle of the motor
  - Supports 1 V PTP Sin/Cos
  - Sin/Cos Frequency: up to 500 kHz
  - Internal Interpolation: up to ×8192
  - Automatic correction of amplitude mismatch, phase mismatch, signal offset
- Resolver
  - 14 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Emulated encoder outputs of the resolver
- Auxiliary encoder inputs (ECAM, follower, etc.) single-ended, unbuffered
- Tachometer & Potentiometer
- Absolute serial encoders:
  - NRZ (Panasonic, Tamagawa, Mitutoyo, etc.)
  - EnDAT 2.2
  - BiSS/SSI

The Gold DC Trombone can provide power (5 V, 2x200 mA max) for encoders, resolver or Halls.

5.1.6. Input/Output

- One **Analog Input** – up to 14-bit resolution
- Six separate programmable **Digital Inputs**, optically isolated, PLC compatible, can be configured to TTL Level, and AP mode.
- Optional functions:
  - Fast event capture
  - Inhibit/Enable motion
  - Stop motion under control (hard stop)
  - Motion reverse and forward limit switches
  - Begin on input
  - Abort motion
  - Homing
  - General purpose
  - Four separate programmable **Digital Outputs**
  - TTL level: optically isolated sink and source
  - PLC: optically isolated source
- Optional functions:
  - Fast output compare (for one output only)
  - Brake control
  - Amplifier fault indication
  - General purpose
  - Servo enable indication
- Pulse and Direction inputs (single-ended)
- PWM current command output for torque and velocity

5.1.7. STO (Safe Torque Off) Inputs

- Two **STO inputs,** optically isolated, PLC compliable, can be configured to TTL Level, and AP mode.

5.1.8. Built-In Protection

- Software error handling
- Abort (hard stops and soft stops)
- Status reporting
- Protection against:
  - Shorts between motor power outputs
  - Shorts between motor power outputs and power input/return
  - Failure of internal power supplies
  - Over-heating
- Continuous temperature measurement. Temperature can be read on-the-fly; a warning can be initiated x degrees before temperature disable is activated.
  - Over/under voltage
  - Loss of feedback
  - Following error
  - Current limits

5.1.9. Status Indication

- Two outputs for bi-color LEDs

5.1.10. Automatic Procedures

- Commutation alignment
- Phase sequencing
- Current loop offset adjustment
- Current loop gain tuning
- Current gain scheduling
- Velocity loop offset adjustment
- Velocity gain tuning
- Velocity gain scheduling
- Position gain tuning

5.2. Gold DC Trombone Dimensions

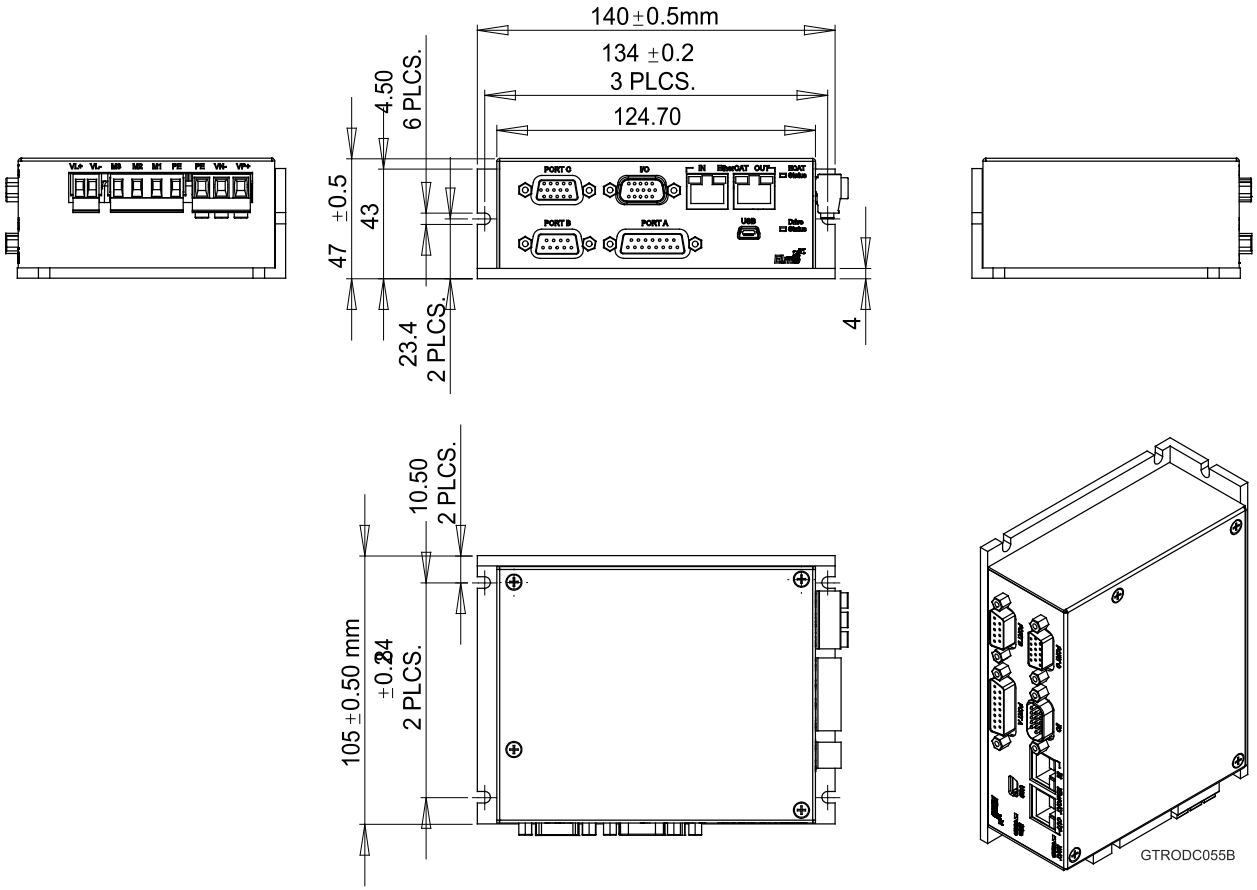


Figure 39: Gold DC Trombone Dimensions

5.3. Environmental Conditions

Feature	Details
Ambient operating temperature	0 °C to 40 °C (32 °F to104°F)
Storage temperature	-20 °C to 85 °C (-4 °F to 185 °F)
Maximum Altitude	10,000 m
Maximum non-condensing humidity	90%
Protection level	IP32

5.4. Control Specifications

5.4.1. Current Loop

Feature	Details
Controller type	Vector, digital
Compensation for bus voltage variations	“On-the-fly” automatic gain scheduling
Motor types	• AC brushless (sinusoidal) • DC brushless (trapezoidal) • DC brush • Linear motors • “Voice” coils
Current control	• Fully digital • Sinusoidal with vector control • Programmable PI control filter based on a pair of PI controls of AC current signals and constant power at high speed
Current loop bandwidth	> 4 kHz closed loop
Current sampling time	Programmable 40 to 120 µsec
Current sampling rate	Up to 20 kHz; default 20 kHz

5.4.2. Velocity Loop

Feature	Details
Controller type	PI + Four advanced filters + Two advanced gain scheduling filters
Velocity control	• Fully digital • Programmable PI and feed forward control filters • On-the-fly gain scheduling according to either speed or position command or feedback. • Automatic, quick, advanced or expert tuning
Velocity and position feedback options	• Incremental Encoder • Digital Halls • Interpolated Analog (sin/cos) Encoder (optional) • Resolver (optional) • Absolute serial encoder **Note:** • With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).
Velocity loop bandwidth	< 500 Hz
Velocity sampling time	80 to 240 µsec (2x current loop sample time)
Velocity sampling rate	Up to 10 kHz; default 10 kHz
Velocity command options	Internally calculated by either jogging or step **Note:** All software-calculated profiles support on-the-fly changes.

5.4.3. Position Loop

Feature	Details
Controller type	"1-2-2" PIP + three advanced filters + one advanced gain scheduling filter
Position command options	• Software • Pulse and Direction
Position loop bandwidth	< 200 Hz
Position sampling time	80 to 240 µsec (2x current loop sample time)
Position sampling rate	Up to 10 kHz; default 10 kHz

5.5. Feedbacks

5.5.1. Feedback Supply Voltage

The Gold DC Trombone has two feedback ports (Main and Auxiliary). The Gold DC Trombone supplies voltage only to the main feedback device and to the auxiliary feedback device if needed.

Feature	Details
Encoder supply voltage	5 V ± 5% @ 2 x 200 mA (maximum)

5.5.2. Feedback Options

The Gold DC Trombone can receive and process feedback input from diverse types of devices.

5.5.2.1. Incremental Encoder Input

Feature	Details
Encoder format	• A, B and Index • Differential • Quadrature
Interface	RS-422
Input resistance	Differential: 120 Ω
Maximum incremental encoder frequency	Maximum absolute: 75 Megacounts per second (18 MHz on A/B)
Minimum quadrature input period (PIN)	53 nsec
Minimum quadrature input high/low period (PHL)	26 nsec
Minimum quadrature phase period (PPH)	13 nsec
Maximum encoder input voltage range	Common mode: ± 7 V Differential mode: ± 7 V

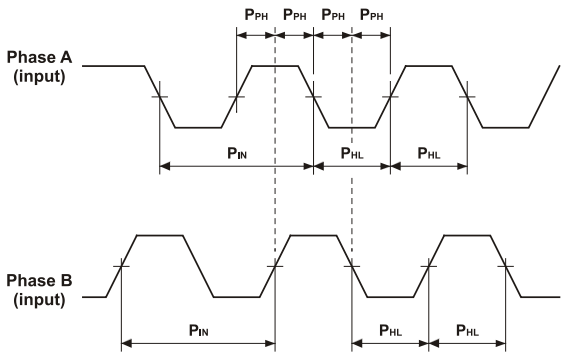


Figure 40: Main Feedback - Encoder Phase Diagram

5.5.2.2. Digital Halls

Feature	Details
Hall inputs	• H_A, H_B, H_C • Single ended inputs • Built in hysteresis of 1 V for noise immunity
Input voltage	Nominal operating range: 0 V < V_{In_Hall} < 5 V Maximum absolute: -1 V < V_{In_Hall} < 15 V High level input voltage: V_{InHigh} > 2.5 V Low level input voltage: V_{InLow} < 1 V
Input current	Sink current (when input pulled to the common): 5 mA
Maximum frequency	f_{MAX} : 4 kHz

5.5.2.3. Interpolated Analog (Sine/Cosine) Encoder

Feature	Details
Analog encoder format	Sine and Cosine signals
Analog input signal level	• Offset voltage: 2.2 V to 2.8 V • Differential, 1 V peak to peak
Input resistance	Differential: 120 Ω
Maximum analog signal frequency	f_{MAX} : 500 kHz
Interpolation multipliers	Programmable: x4 to x8192
Maximum “counts” frequency	2 x 10^9 counts/sec
Automatic errors correction	Signal amplitudes mismatch Signal phase shift Signal offsets
Encoder outputs	See Port C Encoder Outputs Specifications, Section 5.5.3.

5.5.2.4. Resolver

Feature	Details
Resolver format	• Sine/Cosine • Differential
Input resistance	Differential 2.49 kΩ
Resolution	Programmable: 10 to 15 bits
Maximum electrical frequency (RPS)	512 revolutions/sec
Resolver transfer ratio	0.5
Reference frequency	1/Ts (Ts = sample time in seconds)
Reference voltage	Supplied by the Gold DC Trombone
Reference current	up to ±50 mA
Encoder outputs	See Port C Encoder Output Specifications, Section 5.5.3.

5.5.2.5. Absolute Serial Encoder

Feature	Details
Encoder format	• NRZ (Panasonic, Tamagawa, Mitutoyo, etc.) • EnDAT 2.2 • BiSS/SSI
Interface	• RS-485 • Clock – Differential output line • Data – Differential bidirectional line
Input Resistance	Differential 120 Ω
Transmission Rate	Up to 2.5 MHz

5.5.3. Port C Feedback Output

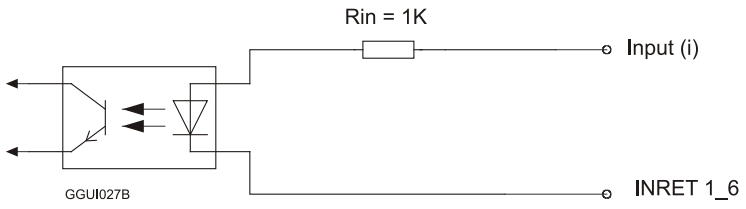
Feature	Details
Emulated output	• A, B, Index • Differential
Interface	RS422
Output current capability	Maximum output current: I_{OH} (max) = 2 mA High level output voltage: V_{OH} > 3.0 V Minimum output current: I_{OL} = 2 mA Low level output voltage: V_{OL} < 0.4 V
Available as options	• Emulated encoder output of any sensor on Port A or Port B • Daisy chain Port A or Port B • Emulated encoder output of internal variables • Emulated encoder outputs of the tachometer • Emulated encoder outputs of the potentiometer
Maximum frequency	f_{MAX}: 8 MHz pulses/output
Edge separation between A & B	Programmable number of clocks to allow adequate noise filtering at remote receiver of emulated encoder signals
Index (marker)	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

5.6. I/Os

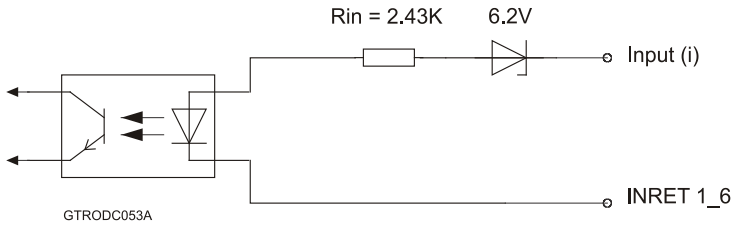
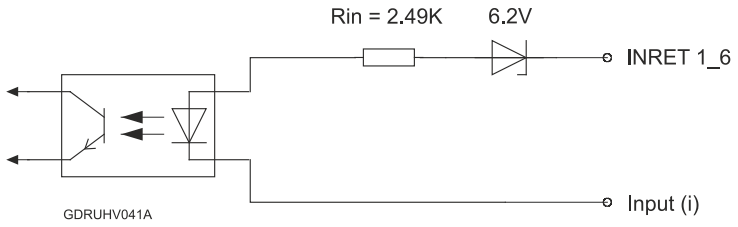
The Gold DC Trombone has:

- 6 Digital Inputs
- 4 Digital Outputs
- 1 Analog Input

5.6.1. Digital Input Interfaces – TTL Mode

Feature	Details
Suffix applicable	T or 1
Type of input	Optically isolated
Input current for all inputs	Iin = 3.8 mA @ Vin = 5 V
High-level input voltage	2.4 V < Vin < 15 V, 5 V typical
Low-level input voltage	0 V < Vin < 0.8 V
Minimum pulse width	>250 µsec for inputs 1-6, >3 msec for STO
Execution time (all inputs): the time from application of voltage on input until execution is complete	0 < T < 250 µsec
High-speed inputs – 1 to 6 minimum pulse width, in high-speed mode	T > 5 µsec if the input functionality is set to latch/capture (index/strobe). **Notes:** • Home mode is high-speed mode and can be used for fast capture and precise homing. • Highest speed is achieved when turning on optocouplers.
 **Figure 41: Digital Input Schematic, for T or 1 suffixes**	
Capture with differential input Port A, Port B Index	T > 0.1 µsec if the differential input functionality is set to touch probe/capture (index/strobe).

5.6.2. Digital Input Interfaces – PLC Mode

Feature	Details
Suffix applicable	S, 0, or AP
Type of input	Optically isolated
Input current for all inputs	Iin = 2 mA @ Vin = 12 V
High-level input voltage	12 V < Vin < 30 V
Low-level input voltage	0 V < Vin < 7 V
Minimum pulse width	>250 µsec for inputs 1-6, >3 msec for STO
Execution time (all inputs): the time from application of voltage on input until execution is complete	0 < T < 250 µsec
High-speed inputs – 1 to 6 minimum pulse width, in high-speed mode	T > 5 µsec if the input functionality is set to latch/capture (index/strobe). **Notes:** • Home mode is high-speed mode and can be used for fast capture and precise homing. • Highest speed is achieved when turning on optocouplers.
 **Figure 42: Digital Input Schematic for S or 0 Suffix**	
 **Figure 43: Digital Input Schematic for AP**	
Capture with differential input Port A, Port B Index	T > 0.1 µsec if the differential input functionality is set to touch probe/capture (index/strobe).

5.6.3. Digital Output Interface – PLC Mode

Feature	Details
Suffix applicable	S or 0
Type of output	Optically isolated source
Maximum supply output (VDD)	30 V
Max. output current I_{out} (max) (V_{out} = Low)	I_{out} (max) ≤ 500 mA for Output 1 I_{out} (max) ≤ 250 mA for Outputs 2 to 4
VOL at maximum output voltage (low level)	V_{out} (on) ≤ 0.3 V
R_L	The external R_L must be selected to limit output current to no more than 500 mA (Output 1) or 250 mA (Outputs 2 to 4). $R_L = \frac{VDD - VOL}{I_{out}(max)}$
Executable time	0 < T < 250 µsec

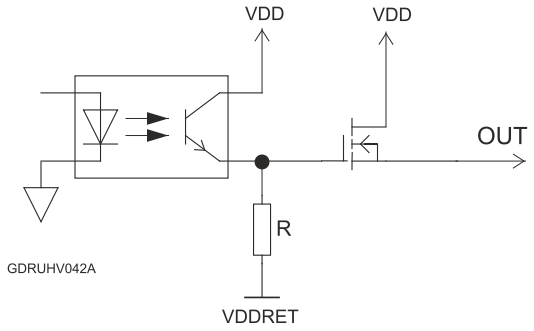


Figure 44: Digital Output Schematic – for S or 0 Suffixes

5.6.4. Digital Output Interface – TTL Mode

Feature	Details
Suffix applicable	T or 1
Type of output	• Optically isolated • Source/Sink
Maximum supply output (VDD)	15 V
Max. output current I_{out} (max) (V_{out} = Low)	7 mA
VOL at maximum output voltage (low level)	V_{out} (on) ≤ 0.4 V
Executable time	0< T< 250 µsec

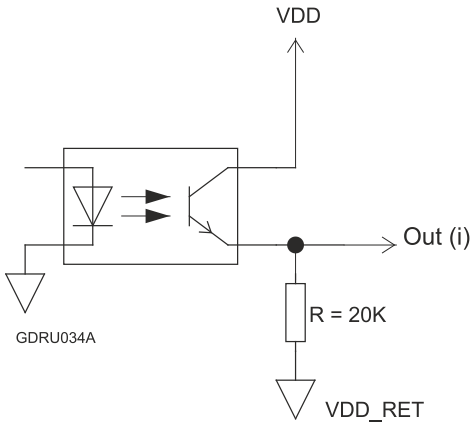


Figure 45: Digital Output Schematic, for T or 1 Suffixes

5.6.5. Digital Output Interface – AP Mode

Feature	Details
Suffix applicable	AP
Type of output	Optically isolated source
Maximum supply output (VDD)	30 V
Max. output current I_{out} (max) (V_{out} = Low)	I_{out} (max) ≤ 300 mA for Output 1 I_{out} (max) ≤ 150 mA for Outputs 2 to 4
VOL at maximum output voltage (low level)	V_{out} (on) ≤ 0.3 V
R_L	The external R_L must be selected to limit output current to no more than 300 mA (Output 1) or 150 mA (Outputs 2 to 4). $R_L = \frac{VDD - VOL}{I_{out}(max)}$
Executable time	0 < T < 250 µsec

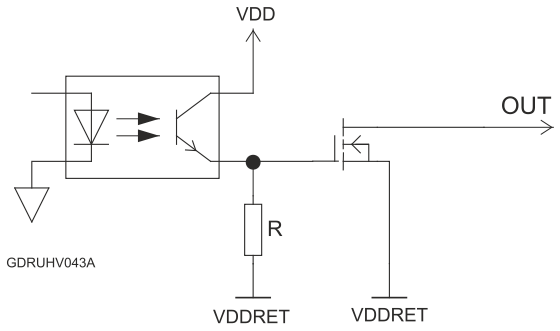


Figure 46: Digital Output Schematic for AP

5.6.6. Analog Input

Feature	Details
Maximum operating differential voltage	± 10 V
Maximum absolute differential input voltage	± 16 V
Differential input resistance	3.74 kΩ
Analog input command resolution	14-bit

5.7. Safe Torque Off (STO)

The Gold DC Trombone has two STO (Safe Torque Off) inputs.

5.7.1. STO Input Interfaces – PLC and AP Modes

Feature	Details
Suffix applicable	S, 0, or AP
Type of input	Optically isolated
Input current for all inputs	Iin = 2 mA @ Vin = 12 V
High-level input voltage	12 V < Vin < 30 V
Low-level input voltage	0 V < Vin < 7 V
Minimum pulse width	>3 ms

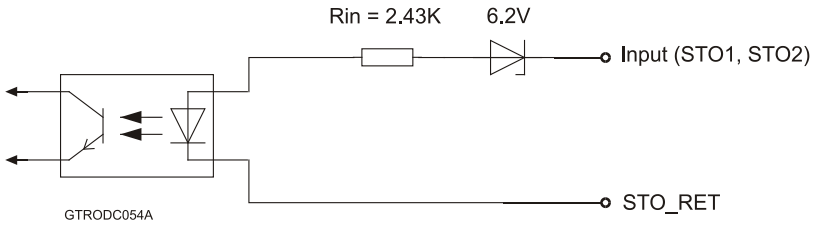


Figure 47: STO Input Schematic for S or 0 Suffix

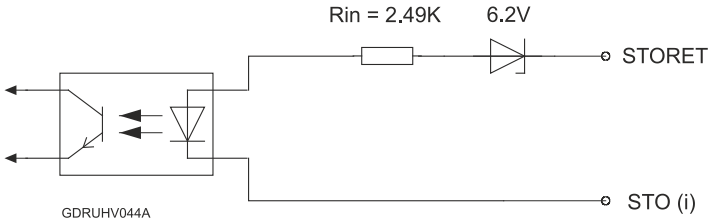


Figure 48: STO Input AP Schematic

5.7.2. STO Input Interfaces – TTL Mode

Feature	Details
Suffix applicable	T or 1
Type of input	Optically isolated
Input current for all inputs	Iin = 3.8 mA @ Vin = 5 V
High-level input voltage	2.4 V < Vin < 15 V, 5 V typical
Low-level input voltage	0 V < Vin < 0.8 V
Minimum pulse width	>3 ms

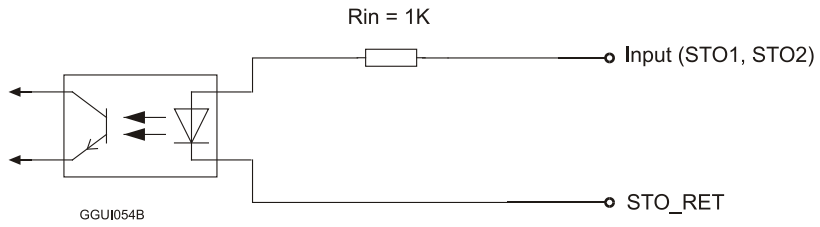


Figure 49: STO Input Schematic for T or 1 Suffix

5.8. EtherCAT Communications Version

Specification	Details
EtherCAT	• 100base-T • Baud Rate: 100 Mbit/sec • CAT5 Cable • CoE, FoE, EoE
Ethernet	• 100base-T • Baud Rate: 100 Mbit/sec • CAT5 Cable • UDP, Telnet
Mini USB	• USB 2.0 Device mode

5.9. CAN Communications Version

Specification	Details
CANopen	**CAN-bus Signals:** • CAN_H, CAN_L, CAN_RET • Maximum Baud Rate of 1 Mbit/sec. **Version:** • DS 301 v4.01 **Layer Setting Service and Protocol Support:** • DS 305 **Device Profile** (drive and motion control)**:** • DS 402
Mini USB	• USB 2.0 Device mode

5.10. Pulse-Width Modulation (PWM)

Feature	Details
PWM resolution	12-bit
PWM switching frequency on the load	1/Ts (factory default 20 kHz on the motor)

5.11. Compliance with Standards

Specification	Details
Quality Assurance	
ISO 9001:2008	Quality Management
Design	
Approved **IEC/EN 61800-5-1, Safety**	Printed wiring for electronic equipment (clearance, creepage, spacing, conductors sizing, etc.)
MIL-HDBK- 217F	Reliability prediction of electronic equipment (rating, de-rating, stress, etc.)
• **UL 60950** • **IPC-D-275** • **IPC-SM-782** • **IPC-CM-770** • **UL 508C** • **UL 840**	Printed wiring for electronic equipment (clearance, creepage, spacing, conductors sizing, etc.)
In compliance with **VDE0160-7 (IEC 68)**	Type testing
Safety	
Recognized **UL 508C**	Power Conversion Equipment
In compliance with **UL 840**	Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
In compliance with **UL 60950**	Safety of Information Technology Equipment Including Electrical Business Equipment
Approved **IEC/EN 61800-5-1, Safety**	Adjustable speed electrical power drive systems
In compliance with **EN 60204-1**	Low Voltage Directive 73/23/EEC

Specification	Details
EMC	
Approved **IEC/EN 61800-3, EMC**	Adjustable speed electrical power drive systems
In compliance with **EN 55011** Class A with **EN 61000-6-2**: Immunity for industrial environment, according to: **IEC 61000-4-2** / criteria B **IEC 61000-4-3** / criteria A **IEC 61000-4-4** / criteria B **IEC 61000-4-5** / criteria B **IEC 61000-4-6** / criteria A **IEC 61000-4-8** / criteria A **IEC 61000-4-11** / criteria B/C	Electromagnetic compatibility (EMC)
Workmanship	
In compliance with **IPC-A-610**, level 3	Acceptability of electronic assemblies
PCB	
In compliance with **IPC-A-600**, level 2	Acceptability of printed circuit boards
Packing	
In compliance with **EN 100015**	Protection of electrostatic sensitive devices
Environmental	
In compliance with **2002/96/EC**	Waste Electrical and Electronic Equipment regulations (WEEE) **Note:** Out-of-service Elmo drives should be sent to the nearest Elmo sales office.
In compliance with **2002/95/EC** (effective July 2006)	Restrictions on Application of Hazardous Substances in Electric and Electronic Equipment (RoHS)